Nortel BWA Type Acceptance Radio Transceiver Test Report

Product Description:	31 GHz Base Station (BTR)
Model:	BTR3101P
Nortel BWA File #	AB6BTR3101P

MITCH HEBERT PI SPECIALIST

DATE NOVEMBER 30, 1999

WINNIPEG,

DECLARATION BY Nortel Networks BWA

The tests were performed from Sep 11 through Sep 30,1999 at the Nortel Networks BWA's EMC Laboratory in Winnipeg.

The following personnel collaborated to this project:

Mitch Hebert, PI Specialist
Eduardo Atanacio, PI Tech

Testing was performed and supervised by the undersigned. The test supervisor attests to the accuracy of the test data recorded in this report.

Performed by: Eduardo Atanacio Date September 30, 1999

Supervised by: Mitch Hebert Date September 30, 1999

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Total number of pages: 45

The results presented in this report refer only to the product(s) described in section 1.

All equipment and instrumentation used during this test have been verified and/or calibrated. All calibration certificates are traceable to the National Research Council of Canada (CNRC) and/or to the American National Institute of Standards and Technology (NIST) standards and can be provided on request.

Nortel BWA is registered ISO 9002:1998, certificate # 766.2.

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1. INTRODUCTION

Object

This test report is being submitted for type acceptance of the Nortel Networks BWA Reunion Radios operating in the LMDS Bands 31.000 to 31.075 GHz and 31.225 to 31.300 GHz. The ReUnion radios are designed to provide wide-band multi-carrier point-to-multi-point subscriber services in an efficient and cost effective manner. The adherence to the rules for LMDS radios in these bands is demonstrated in the following pages. Nortel Networks BWA is currently seeking type approval on this product.

Equipment under Test Description

The Nortel Networks BWA 31 GHz radio product is of wide band design. The power amplifiers and the LNA are designed to provide gain over the entire 31.000 to 31.300 GHz band. The BTR and CTR are of a single conversion design. A single DRO serves both the transmit and receive path. The BTR provides a maximum power output of 1 watt for a single un-modulated tone. Thus the power limitation requirement of FCC part 101 section 101.113 is satisfied. The following tables identify the EUTs:

Model #	Description	Manufacturer	Part #
BTR3101	Base Transceiver	Nortel BWA	NTVG21AA

Model #	Order Code	uW Tx (GHz)	uW Rx (GHz)	RF Tx (MHz)	RF Rx (MHz)	BW	Separation
BTR3101	NTVG21AA	31.0–31.075	31.225-31.3	450-525	225-300	75	700

Antennae

The antennas used by the transceivers are the following

Nortel Part Number	System	Spread (degrees)	Isotropic Gain (dBi)
A0779698	Base	90	15.8 – 17.8
A0781443	Base	45	18.2 – 20.2
A0782146	Base	15	24.0 – 26.0

General

Tests were performed on a production sample of the BTR according to standards and directives indicated on the table in paragraph 1.1. All measurements were performed in accordance to the measurement procedures outlined in these standards or detailed in this report. The BTR is intended to fall under the 31000 to 31075 MHz section of the Part 101.109 table. The complimenting customer transceiver (CTR) is intended to fall under the 31225 to 31300 MHz section and will be documented under NTVG22AA and FCC ID AB6CTR3101P

Results

The following table summarizes the EUT test results of the testing described in this report:

Standard	Test Description	Para. No.	Results
FCC part 101 section 101.111	Spectral Mask	(a)(2)(ii)	Compliant
FCC part 101 section 101.111	Conducted Emissions except mask region	(a)(2)(iii)	Compliant
FCC part 101 section 101.111	Radiated Emissions except mask region	(a)(2)(iii)	Compliant
FCC part 101 section 101.105 101.111TSB10F – June 1994	Adjacent Channel Interference	4.2.1	Compliant
FCC part 101 section 101.105 TSB10F – June 1994	Co-Channel Interference	ANNEX B	Compliant
FCC part 2, Section 2.995 (a) (1), (b) and FCC part 101 section 101.107	Frequency Stability Over Temperature	4	Compliant

Test Facilities Description

The Nortel Network BWA EMC facility is a shielded 3m room. The room is provided with input voltages of 120 and 240 V ac, which are filtered through Corcom filters before entry. Due to lab construction, the radiated measurements were performed in an open lab environment. A reference sweep was taken to demonstrate the ambient conditions.

Test Equipment

The following is a list of test equipment used to perform all tests described in this report.

Equipment	Manufacturer	Model	Serial or Asset #	Cal due (Y/M/D)
Spectrum Analyzer	Hewlett Packard	HP 8665E	02940	10/00
Spectrum Analyzer	Hewlett Packard	HP 8663E	3611A05001	09/00
Synthesized Sig. Gen.	Anritsu	69369A	981807	04/00
Power Meter Power Sensor	Anritsu Anritsu	ML2438A MA2475A	97400074	07/00 07/00
Mixer Assembly 40 to 60 GHz	Millitech/Nortel BWA	MHB-19-RD3A0	MS-118086	08/00

Equipment	Manufacturer	Model	Serial or Asset #	Cal due (Y/M/D)
Mixer Assembly 60 to 90 GHz	Millitech/Nortel BWA	MHB-12-RD3A0	MS-118101	08/00
Mixer Assembly 90 to 140 GHz	Millitech/Nortel BWA	MHB-08-RD3A0	MS-118090	08/00
Mixer assembly 140-170 GHz	Millitech/Nortel BWA	CDA-06-DC0253	017-8943	03/00
Power Supply	Hewlett Packard	6544A	US36390168	-----
Power Supply	Hewlett Packard	6554A	US36340233	-----
Frequency Counter	XL microwave	3460	980338143	04/00
Antenna Bilog 30 to 1000 MHz	Shaffner-Chase	CBL6112B	2261	06/00
Horn Antenna 1 to 18 GHz	EMCO	3115	9711-5345	06/00
Horn Antenna 14 to 40 GHz	Shaffner-Chase	BBHA 9170	9046	06/00

2. CONDUCTED EMISSIONS

Tested by: Mitch Hebert and Eduardo Atanacio

The test was performed to validate the requirements specified in FCC part 101 Section 101.111 (a)(2)(iii)

Test Conditions

Temperature	22 to 25C,
Primary Voltage	BTR -48 V

Test Results

The EUT does comply with the specification referenced in the Part 101.111 requirement.

Measurement Data

See on Appendix A for test results and setup photographs.

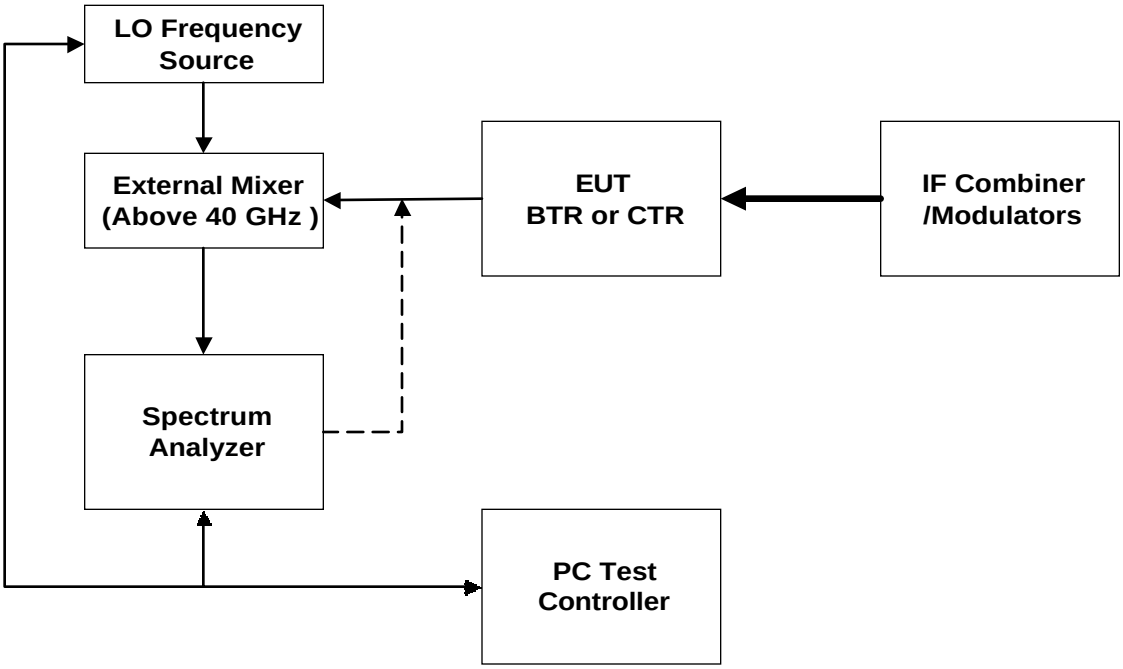
Test Method

Nortel processing equipment stimulated the EUT (BTR) with digitally modulated 16 QAM signal. The modulator output signals are then combined, through a passive combiner, and fed into the input to the BTR. The output is examined directly by a spectrum analyzer for up to frequencies of 40GHz. External mixers are used for frequencies greater than 40GHz. A synthesized frequency generator stimulates the external mixer's local oscillator input. The spectrum analyzer, synthesized generator and all calculations are administered by a Labview software application on a PC.

Test System Test Configuration

Figure 1.0 presents a simplified block diagram of the conducted emissions test set-up. For measurements above 40GHz, a PC controlled a synthesized generator programming the LO frequency input to the external mixer, so that the difference frequency between what is measured and the LO frequency is 100MHz. Below 40GHz, the output of the EUT was directly connected to the input of the spectrum analyzer.

A reference passband response is recorded, of four 16 QAM modulated carriers, occupied bandwidth of 40MHz for the BTR. The measured reference is used to determine the out of band emissions, by measuring the relative differences between the reference and the measured emission.


LO Frequency Source
External Mixer (Above 40 GHz)
EUT BTR or CTR
IF Combiner /Modulators
Spectrum Analyzer
PC Test Controller

3. RADIATED EMISSIONS

Tested by: Mitch Hebert and Eduardo Atanacio

Test was performed to validate the requirements specified in FCC part 2, section 2.997; and FCC part 101 Section 101.111.

Test Conditions

Temperature	20-25C,
Primary Voltage	BTR -48 V dc

Test Results

The EUT does comply with the specification referenced in the Part 101.111 requirement.

Measurement Data

See on Appendix B for test results and setup photographs.

Test Method

Nortel processing equipment stimulated the EUT (BTR) with digitally modulated 16 QAM signal. The modulator output signals are then combined, through a passive combiner, and fed into the input to the BTR and/or CTR. The output is examined directly by a spectrum analyzer for up to frequencies of 40GHz. External mixers are used for frequencies greater than 40GHz. A synthesized frequency generator stimulates the external mixer's local oscillator input. The spectrum analyzer, synthesized generator and all calculations are administered by a Labview software application on a PC.

Test System Configuration

Figure 2.0 presents a simplified block diagram of the radiated emissions test set-up. For measurements above 40GHz, the antennae is positioned 30cm from the EUT; a PC controlled a synthesized generator programming the LO frequency input to the external mixer, so that the difference frequency between what is measured and the LO frequency is 100 MHz. External mixers are connected to Millitech horn antennae, covering the band 40 to 60GHz, 60 to 90GHz, 90 to 140GHz and 140 to 170 GHz. Below 40 GHz, the antenna is positioned 1m from the EUT; the input to the spectrum analyzer was connected to various antennas a Chase 30 to 1000MHz bilog, EMCO 1 to 18GHz horn, and Chase 14 to 40GHz horn.

A reference passband response is recorded, of four 64 QAM modulated carriers, occupied bandwidth of 40 MHz for the BTR. The test antennae and the EUT antenna are positioned at a given distance, to produce a maximum amplitude response of the passband. The antennae are held in this position during the entire testing of up to 170 GHz. The measured reference is used to determine the out of band emissions, by measuring the relative differences between it and the measured emission.

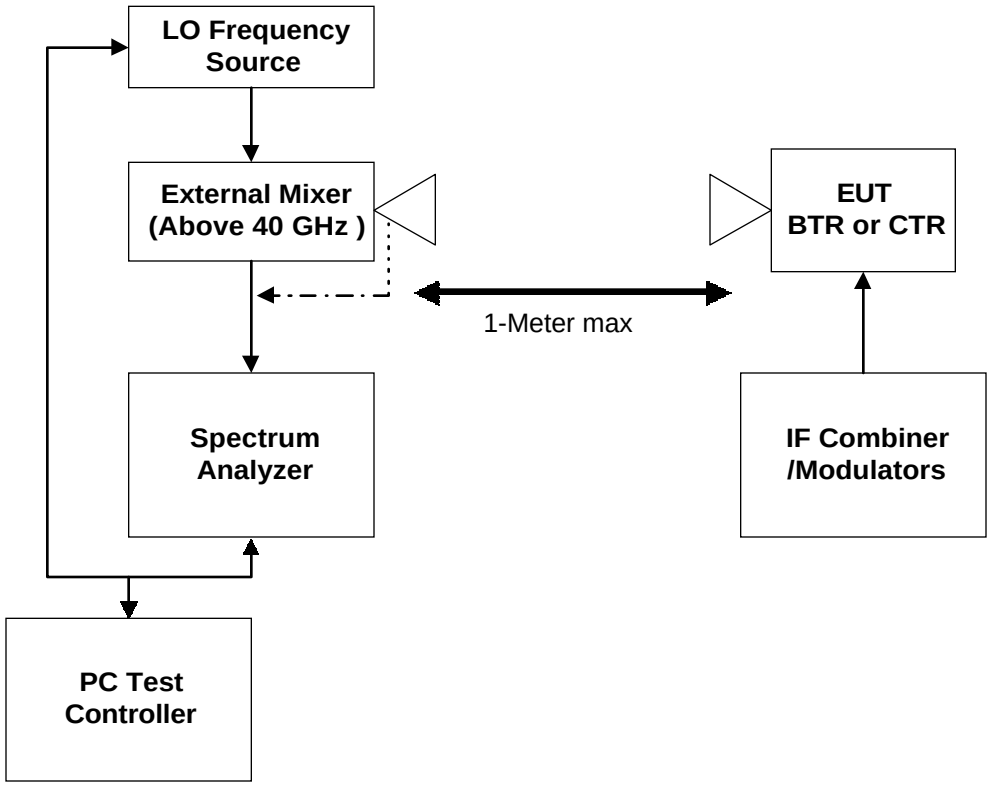


Figure 2.0: Test Setup Configuration for Radiated Emissions

4. TEMPERATURE STABILITY TESTS

Tested by: Mitch Hebert and Eduardo Atanacio

Test was performed to the validate the requirement of part 101, section

Test Conditions

Temperature	-40C to +50C,
Primary Voltage	BTR -48 V dc

Specifications

Requirement specified in FCC part 101, section 101.107, and frequency tolerance of ±0.01%

Test Results

The BTR complies with the frequency tolerance stated in the specification paragraph

Measurement Data

See on Appendix C for test setup and photographs.

Test Method

Tests were performed on a BTR, these units were placed into a temperature chamber, and the temperature profile used for temperature is referenced in FCC part 2, section. A base line frequency measurement is made at first ambient temperature. With the power not applied to the EUT, the temperature is then decreased by the programmed interval (10C) and allowed to “soak” for a period time specified by the user.(20min). This time allows the internal component temperature to stabilize. Once the plateau has been achieved, the power is applied to the EUT and the frequency is measured to 6 significant digits.

Test System Configuration

Figure 3.0 presents a simplified block diagram of the temperature stability test set-up. The PC controls the temperature profile of the temperature chamber. The specified temperature profile is –40°C to +50°C.

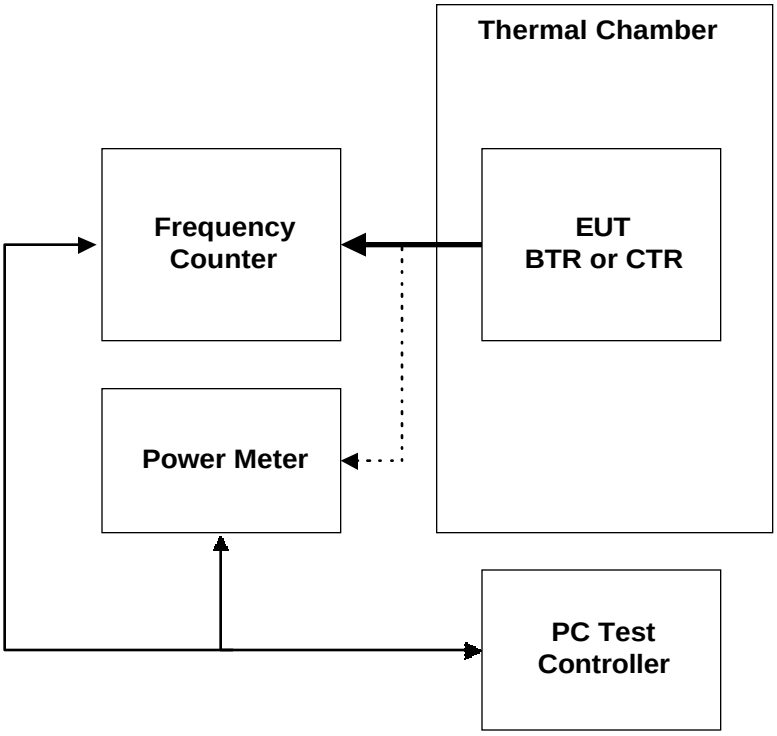


Figure 3.0: Test Setup Configuration for Temperature Stability Tests

5. CO/ADJACENT CHANNEL TEST

Tested by: Mitch Hebert

Test Conditions

Temperature	25C,
Primary Voltage	BTR -48 V dc

Minimum Specifications

As specified in Part 101.105(c)(6), the protection criteria shall be at least 0dB for adjacent channel and as found in TIA Bulletin TSB-10 Table B-1, the limits for 4, 16 and 64 QAM are 19.5, 26.9 and 33.1 dB respectively for co-channel.

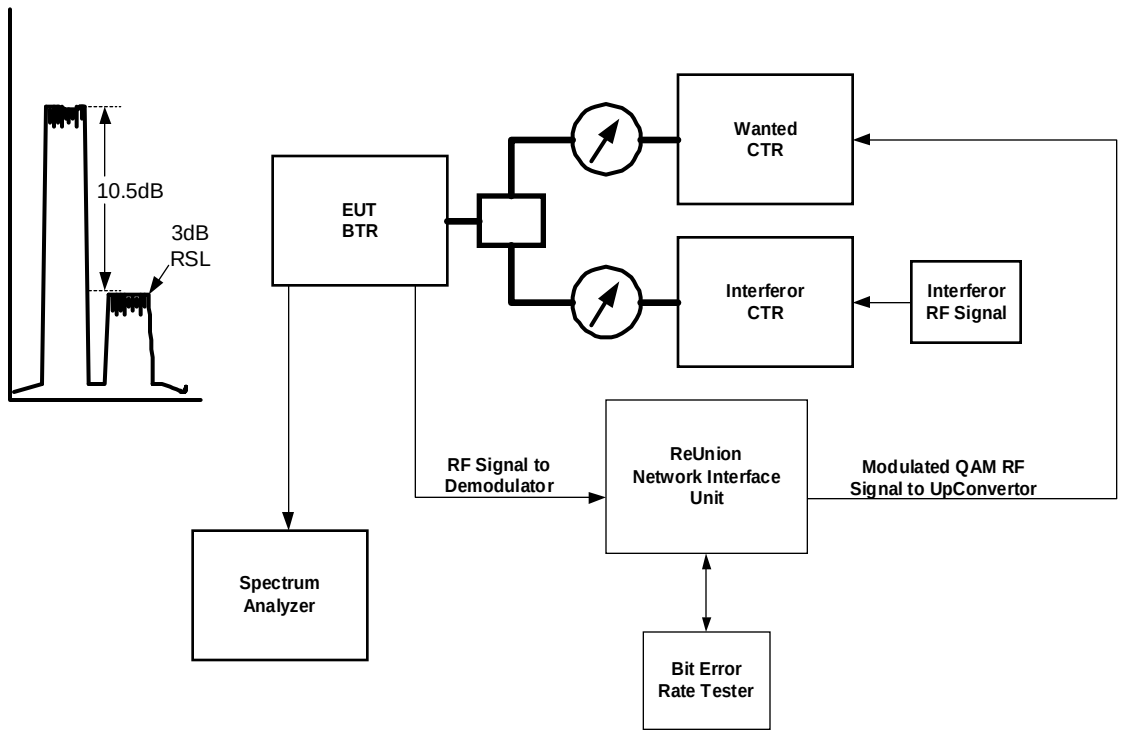
Adjacent Channel Test Method

Nortel translation equipment (CTR) is stimulated with digitally modulated 16 QAM RF signals. The two signals (wanted and interferor) are combined, up-converted and fed into the microwave receive of the EUT (BTR). The wanted CTR output is adjusted such that a quality QAM signal is present. An inline vane attenuator is adjusted until a payload BER of 10^{-6} is achieved. The level is then increased by 3dB. The interfering signal is applied and adjusted such that the BER of 10^{-6} is achieved. The power density of the wanted and interfering carrier are recorded. It should be noted that the vane attenuation reading is noted and it is removed so that accurate measurements are easily made at the microwave flange of the receiver.

Co-Channel Test Method

Nortel translation equipment (CTR) is stimulated with digitally modulated 16 QAM signals. The two signals (wanted and interferor) are combined and fed into the microwave receiver of the EUT (BTR). The wanted CTR output is adjusted such that a quality QAM signal is present. An inline vane attenuator is adjusted until a payload BER of 10^{-6} is achieved. The wanted output is then increased by 3dB and the level is recorded. The interfering signal is then applied at maximum in-line attenuation. The interfering signal is adjusted until the payload BER reaches $10^{-6.}$ The interfering signal is removed. The power density of the wanted carrier is measured and recorded. The wanted carrier is then removed and the interfering signal is measured and recorded. The two measurements should be at least 20.9 dB. It should be noted that the vane attenuation reading is noted and it is removed so that accurate measurements are easily made at the microwave flange of the receiver.

Test System Test Configuration



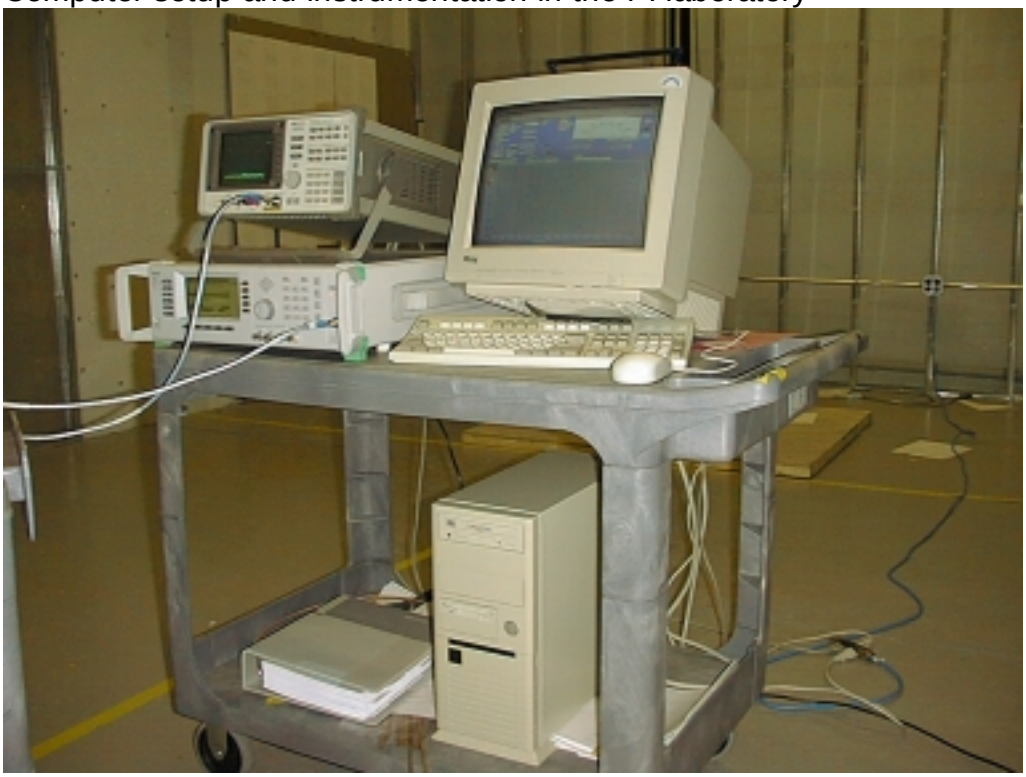
The figure below represents a simplified block diagram of the adjacent and co-channel interference test set-up. 8.0Msps carriers were used giving a bandwidth of 10MHz. Measurements at 4, 16 and 64 QAM were performed using a BER trigger metric of 3dB RSL. For ease of measurement, the relative levels were measured at the RF output of the receiver.

APPENDIX A

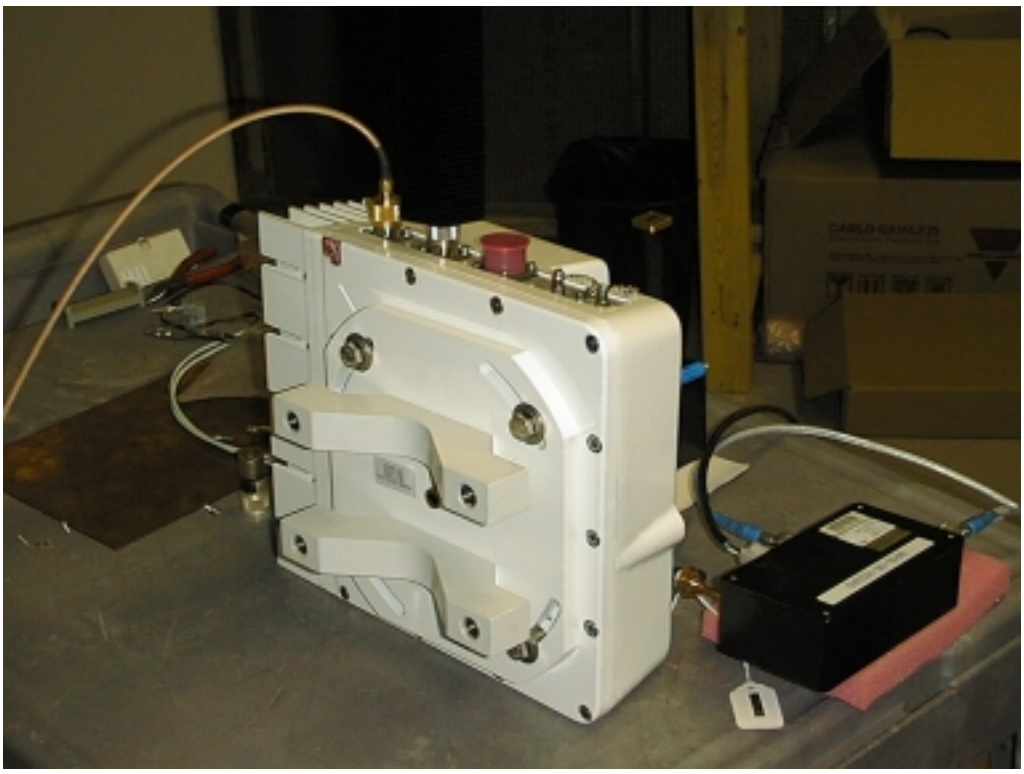
Conducted Emissions Measurement Results

6. CONDUCTED EMISSIONS MEASUREMENT RESULTS

Computer setup and instrumentation in the PI laboratory



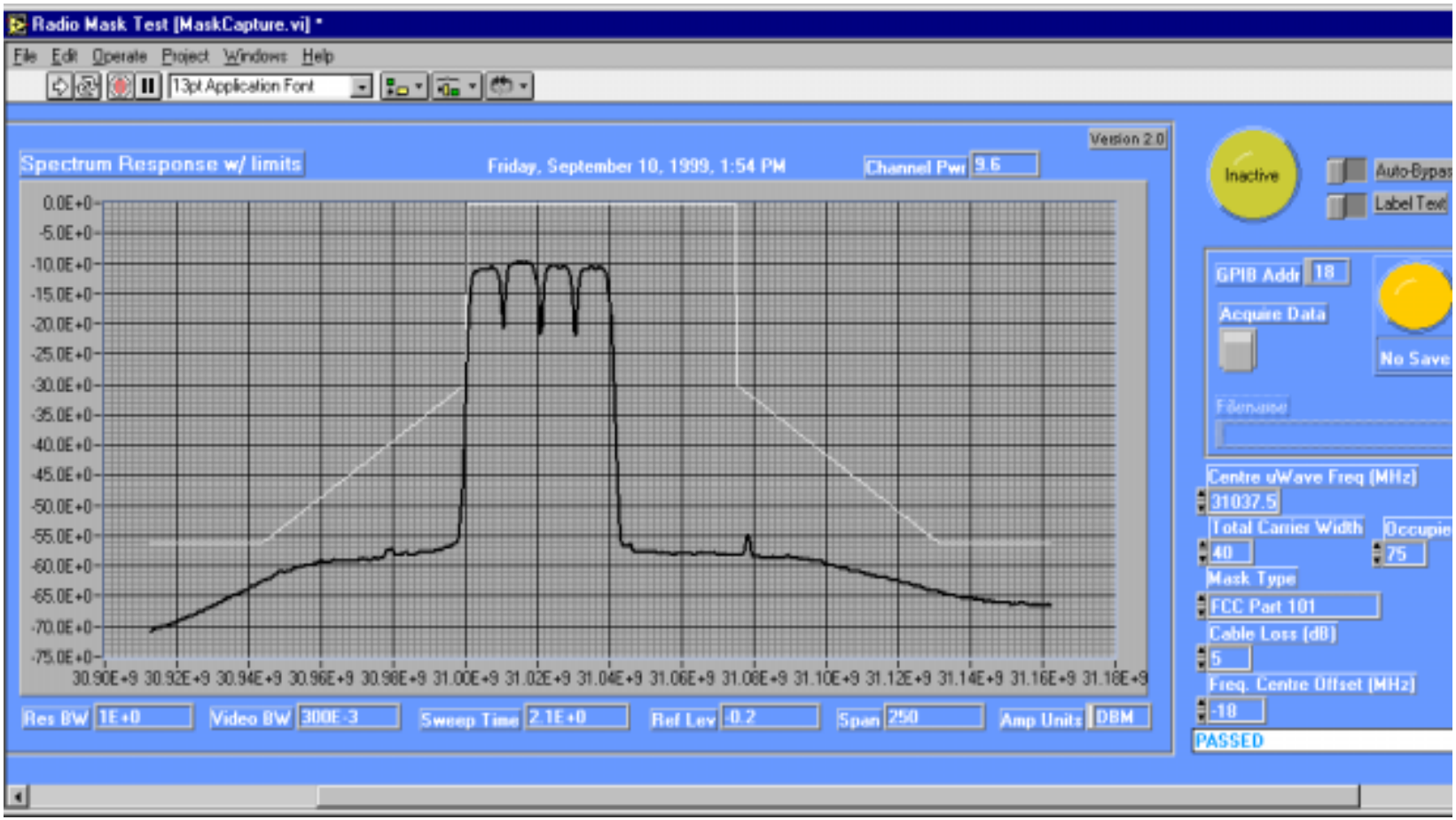
Connection to the BTR using the wave-guide connection



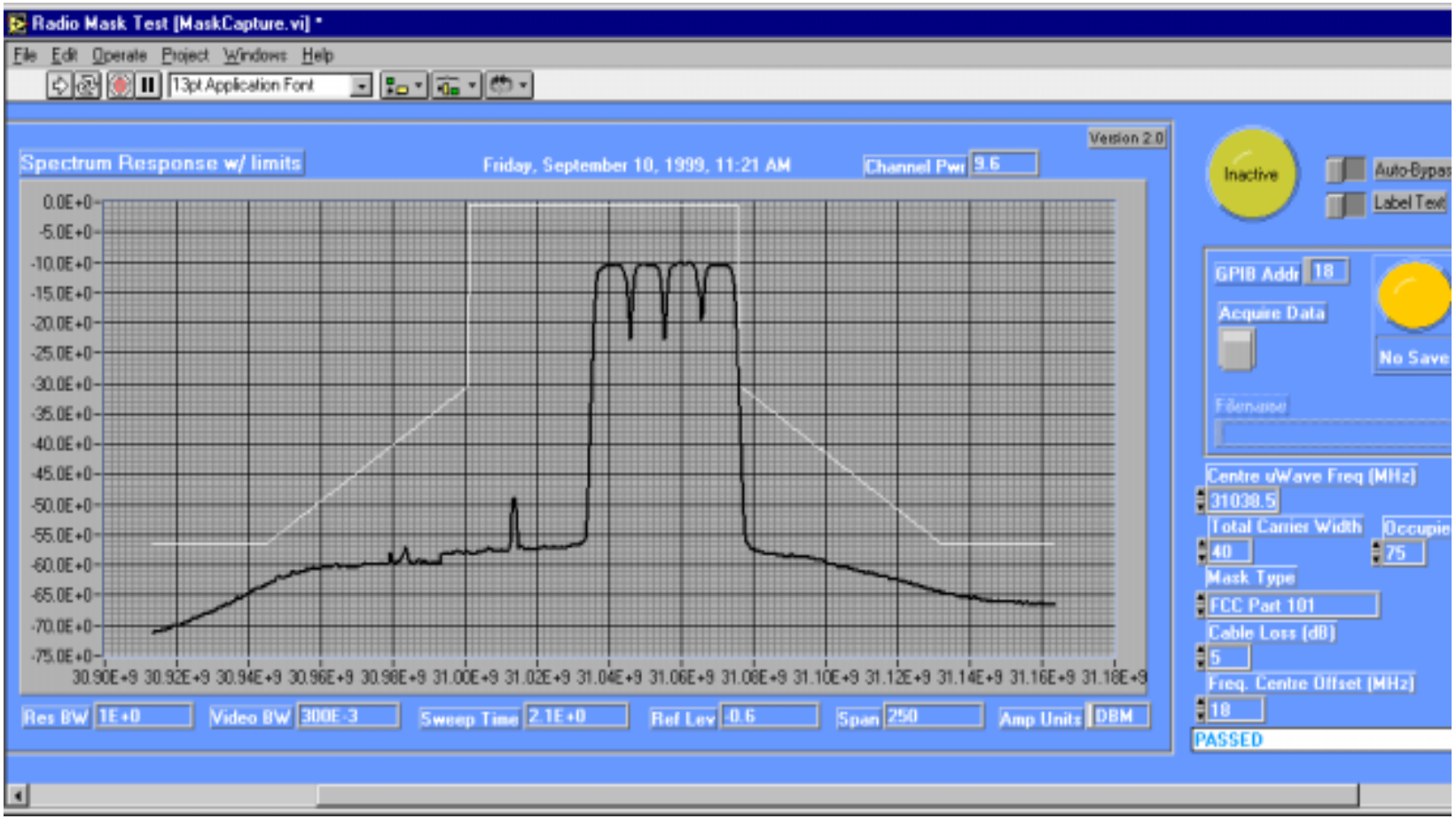
BTR 31-01P, 4 carrier QAM 64 modulated - In-band carriers

The emission showing amplitude and angle-modulated (D) with two or more channels (7) which could contain data or telephony (W). The signal has a maximum occupied bandwidth of 40MHz. (40M0). Equipment Type 40M0D7W The following pictures show 4 – 10MHz carriers across the minimum, maximum of the 75MHz band at a channel power of 15dBm Limit calculations can be found in Appendix D.

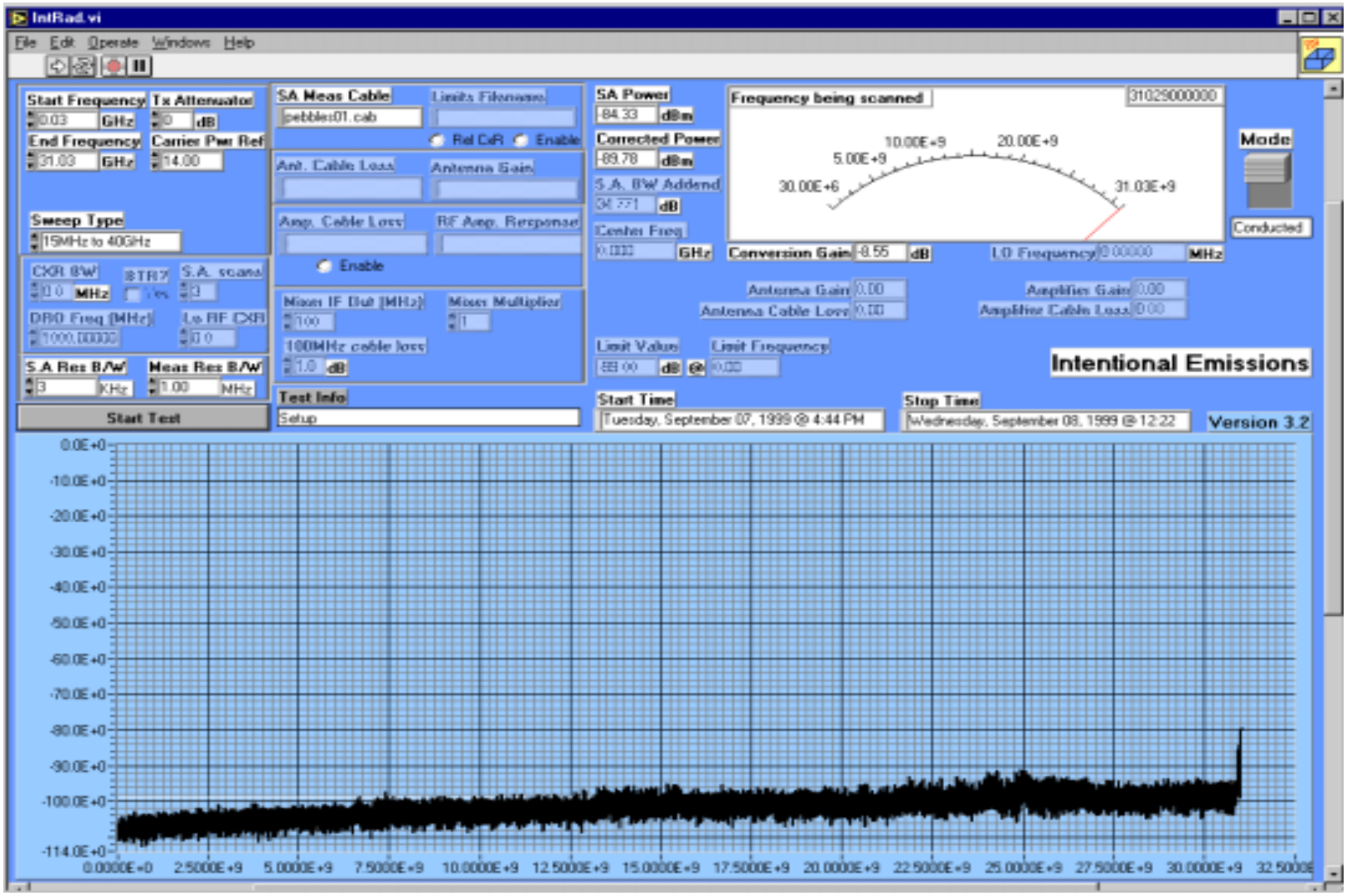
BTR 31-01P 4-10 MHz Carriers, 16 QAM (Low Side)



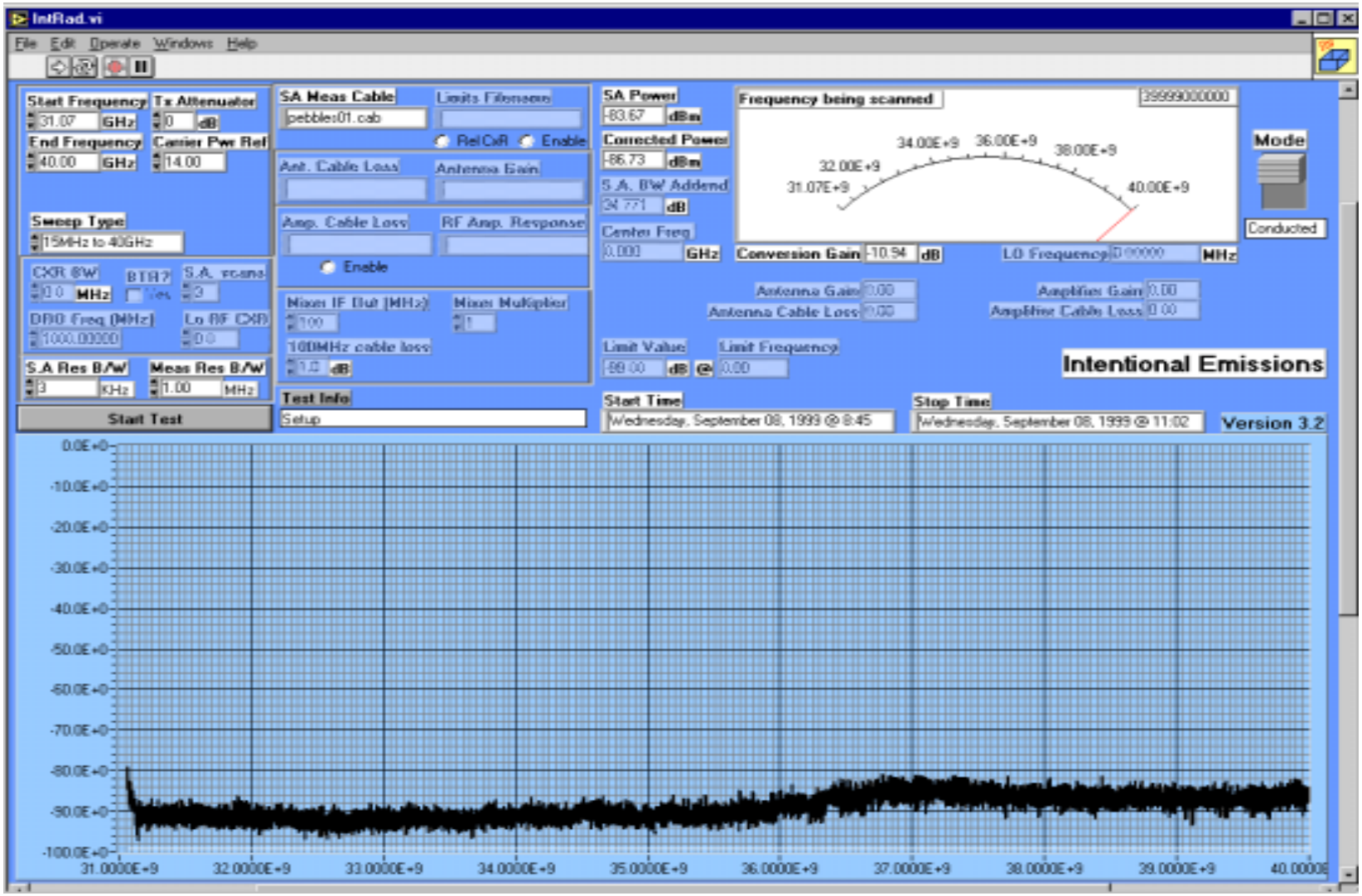
BTR 31-01P 4-10 MHz Carriers, 16 QAM (High Side)



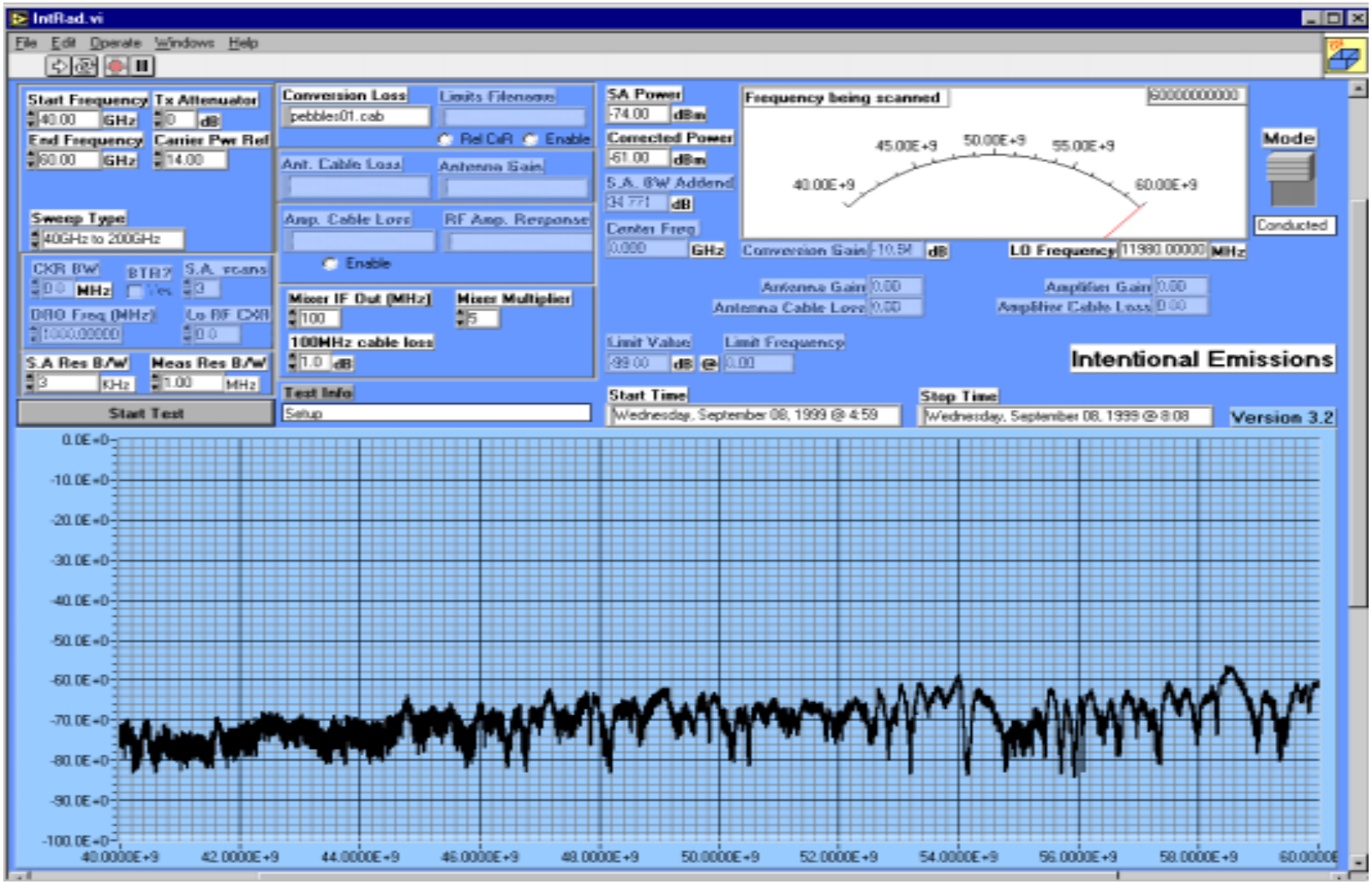
BTR 31-01P, 4 carrier QAM 64 modulated. – 30MHz to edge of carriers



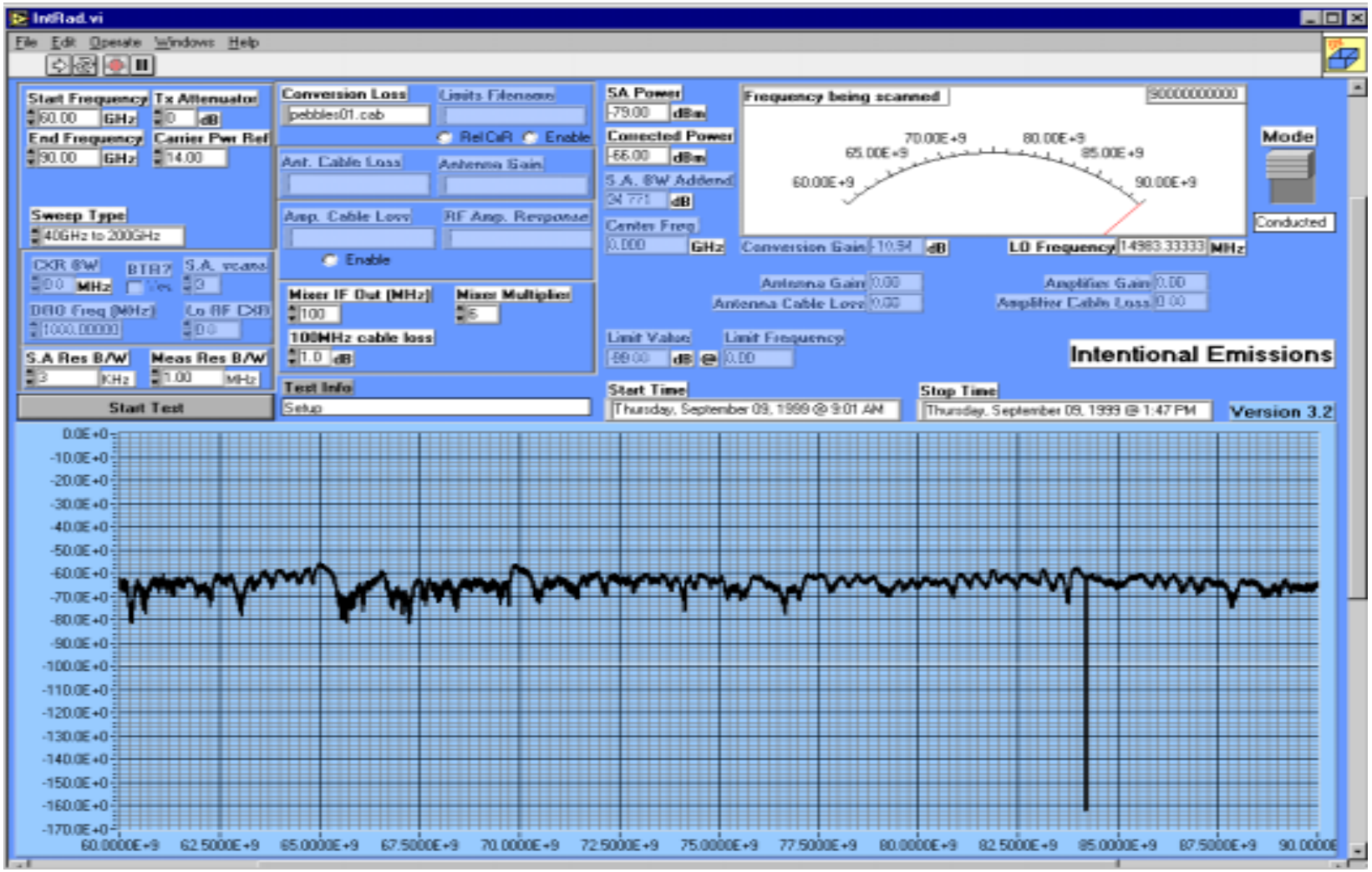
BTR 31-01P, 4 carrier QAM 64 modulated. – Edge of carriers to 40GHz



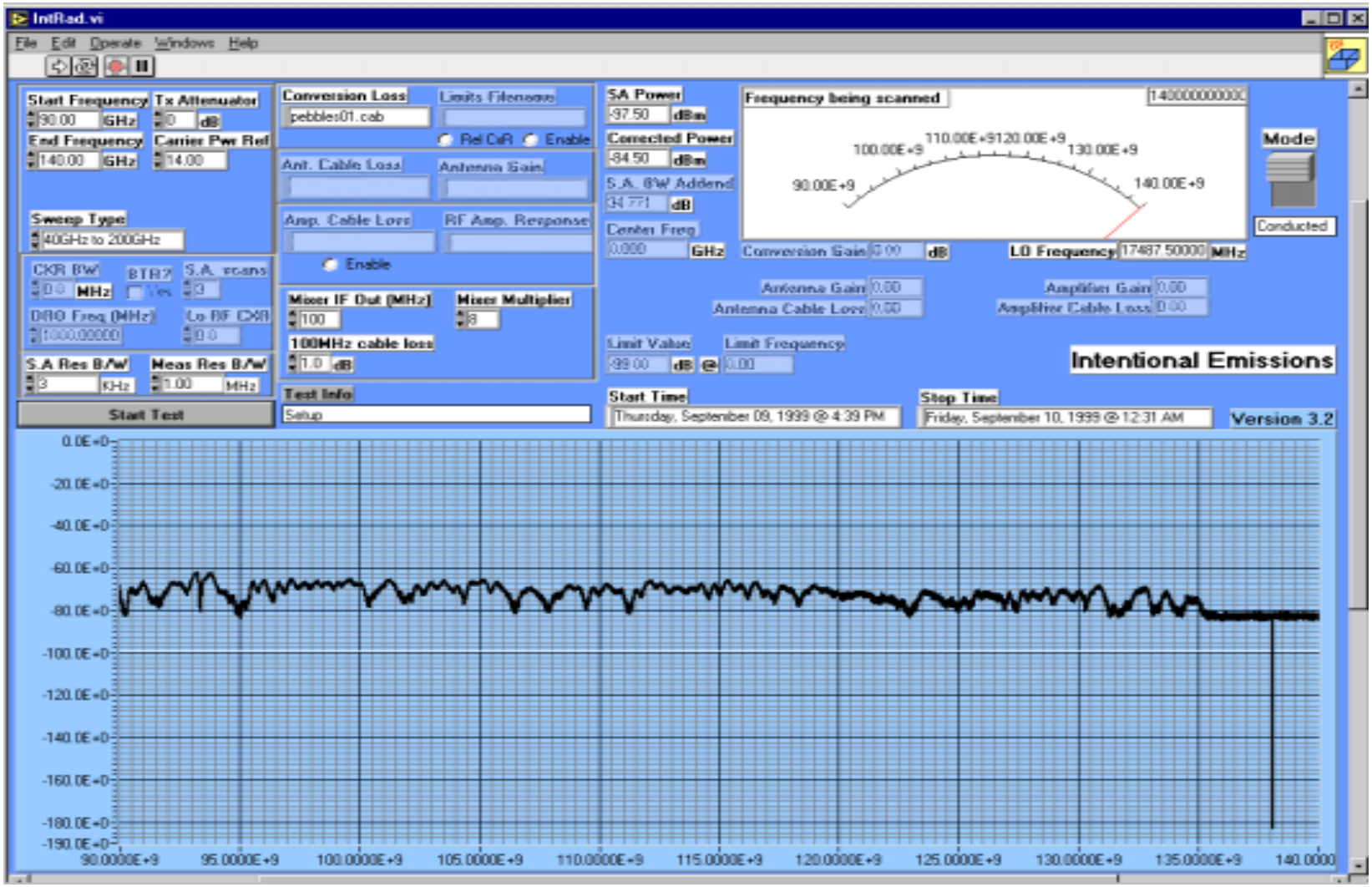
BTR 31-01P Conducted Emissions Test (40.0 GHz – 60.0 GHz



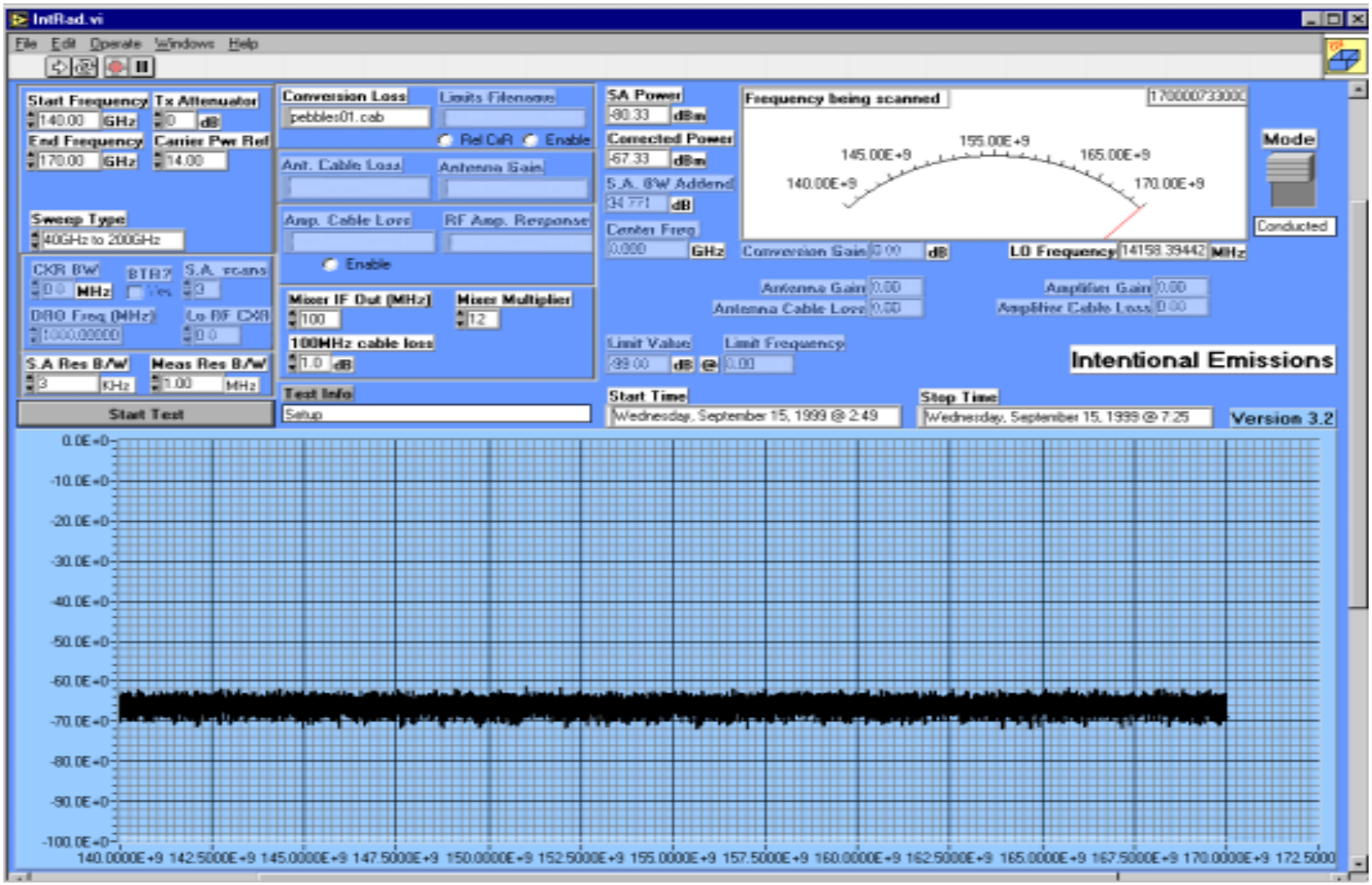
BTR 31-01P Conducted Emissions Test (60.0 GHz – 90.0 GHz)



BTR 31-01P Conducted Emissions Test (90.0 GHz – 140.0 GHz)



BTR 31-01P Conducted Emissions Test (140.0 GHz – 170.0 GHz)

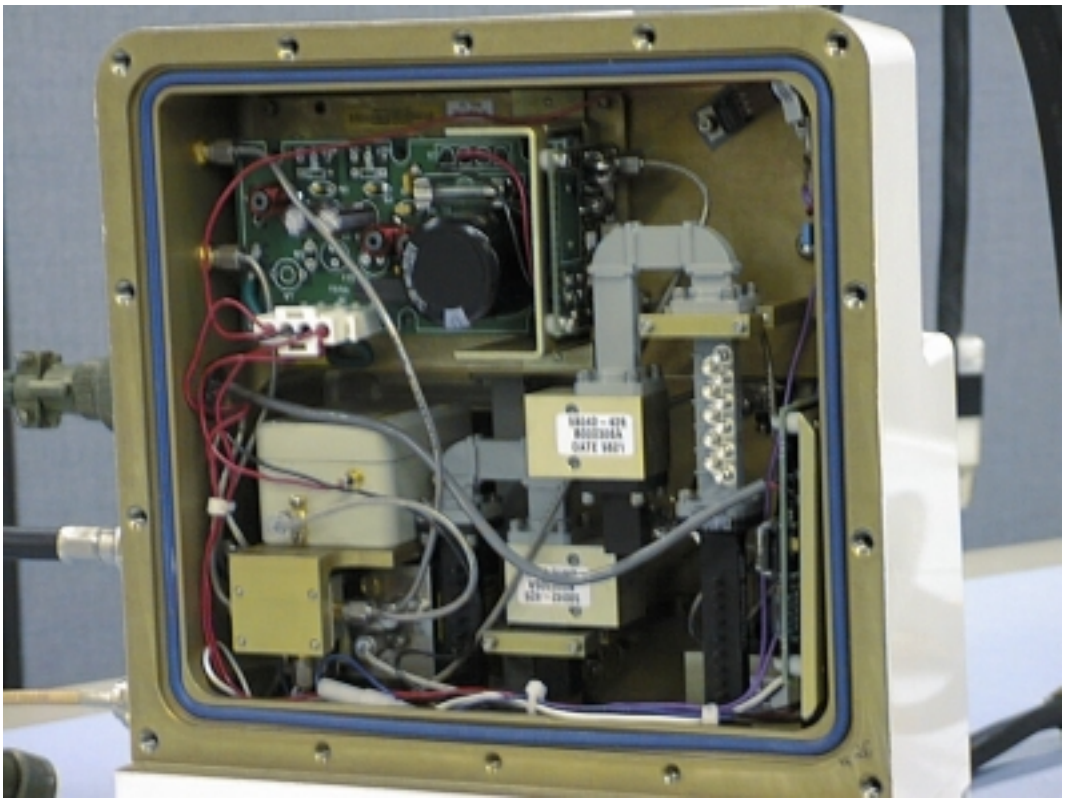


APPENDIX B

Radiated Emissions Measurement Results

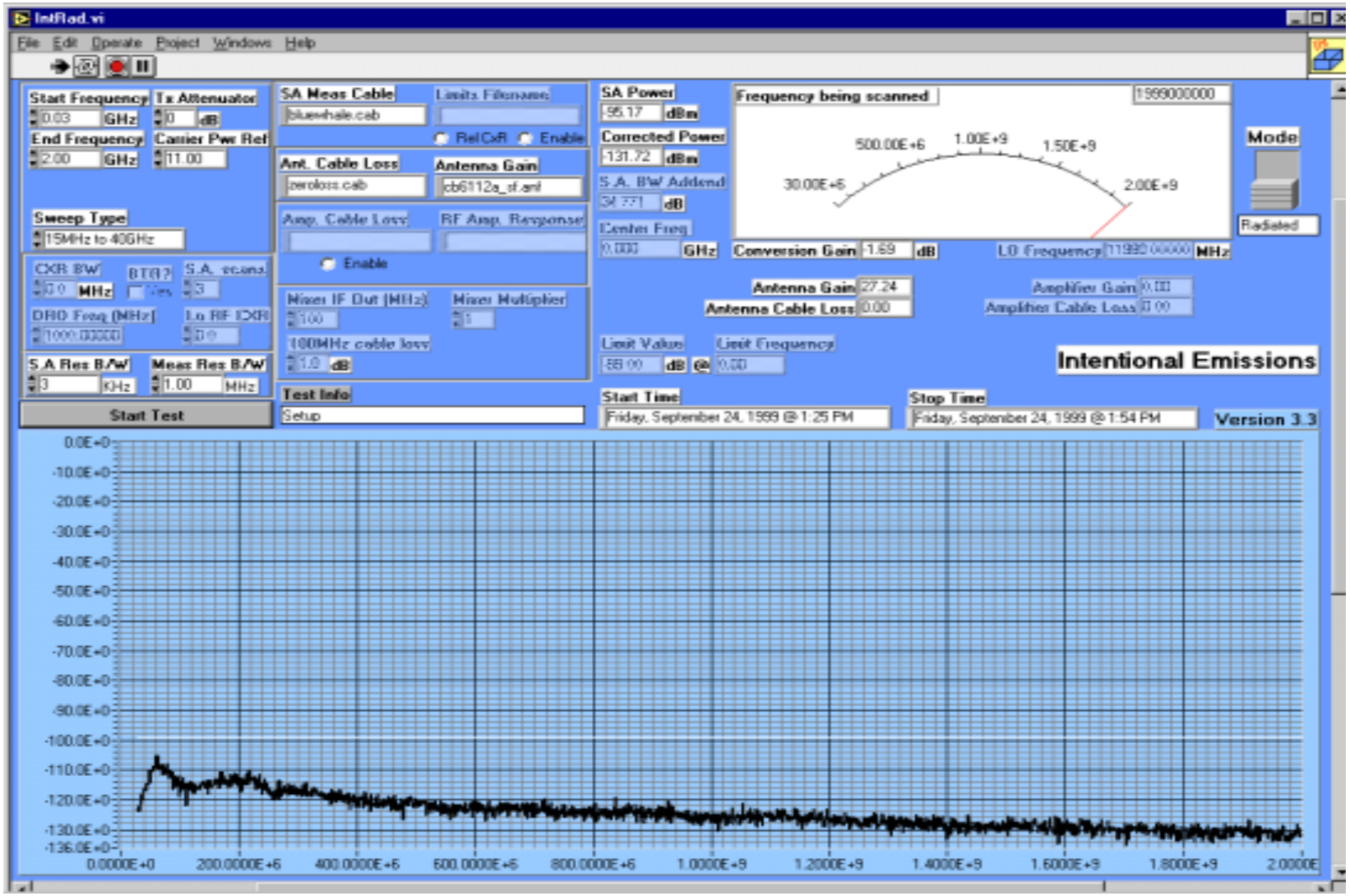
7. RADIATED EMISSIONS MEASUREMENT RESULTS

Radiated test using the 40-60GHz horn.

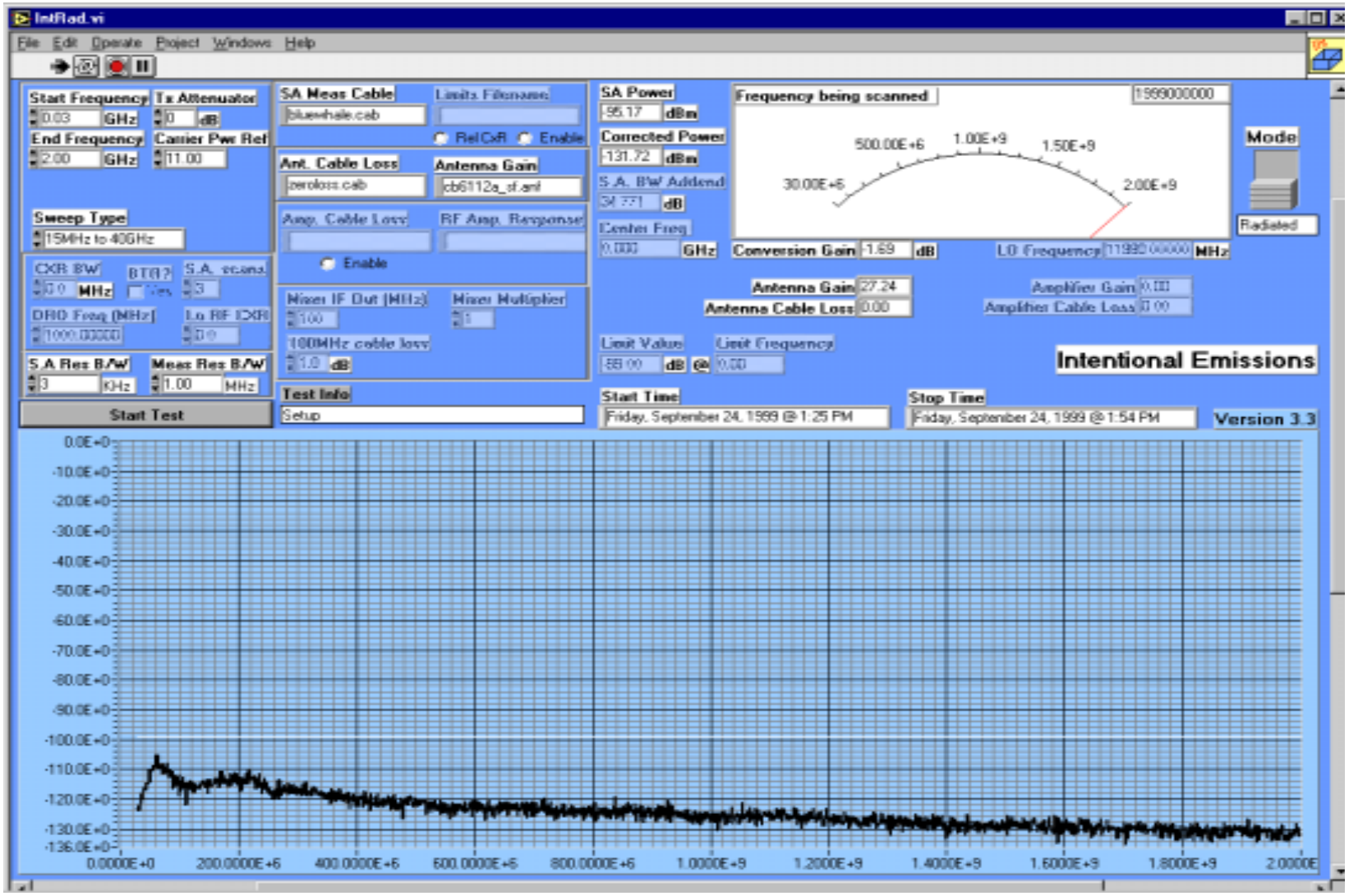


BTR with the back cover removed

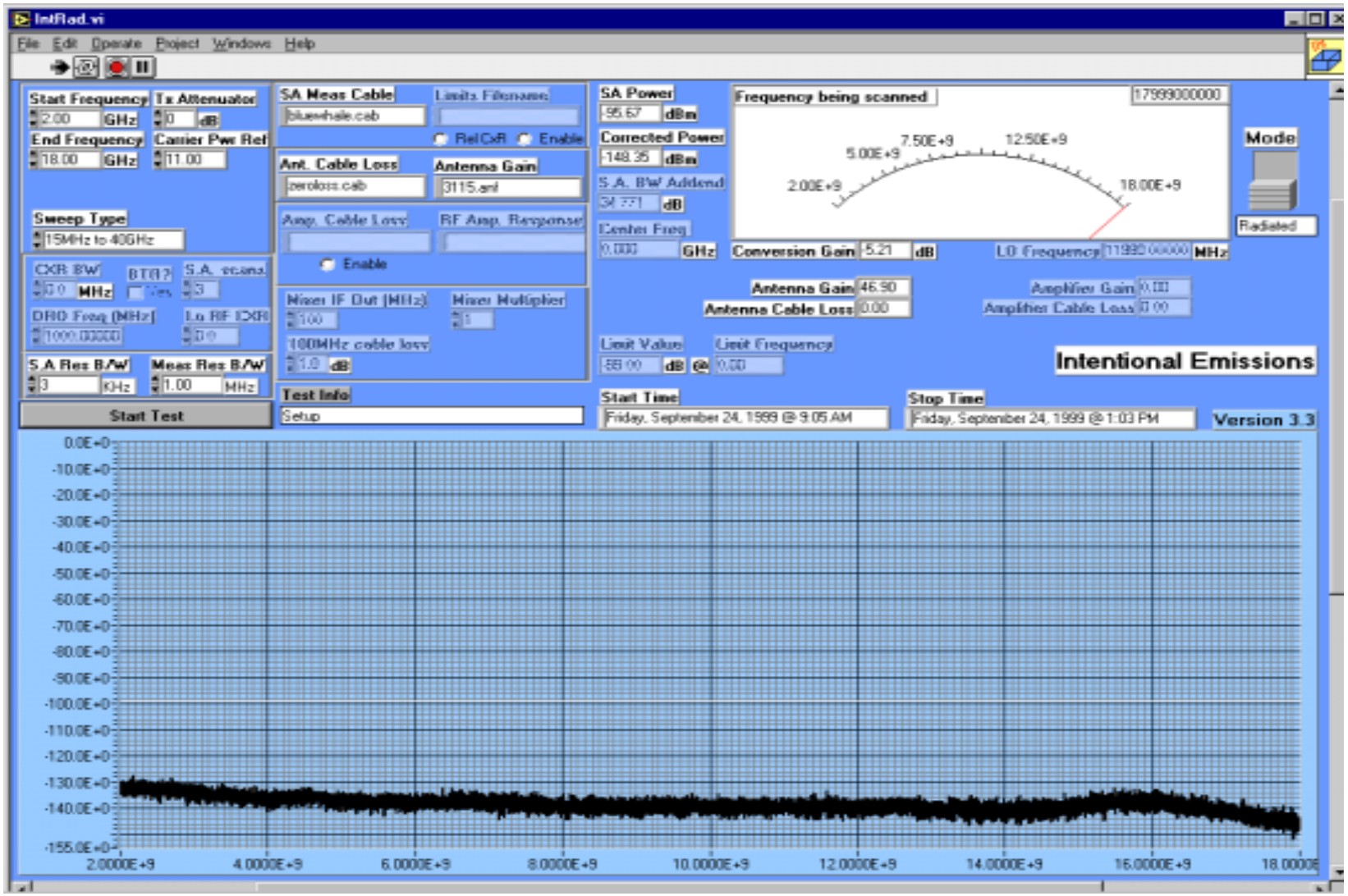
BTR 31-01P Vertical Radiated Emissions Test 30MHz-2GHz



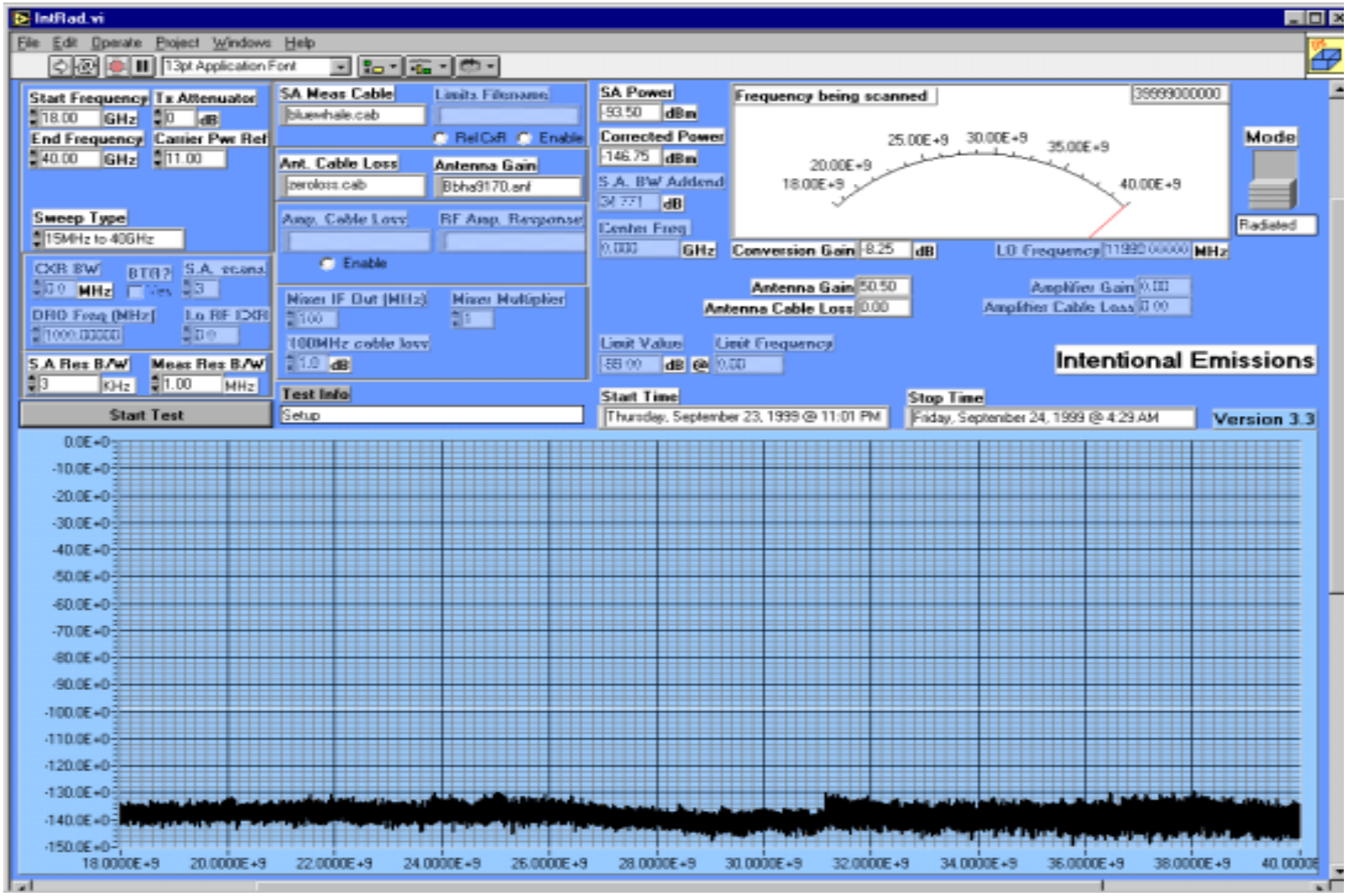
BTR 31-01P Vertical Radiated Emission Test 2.0GHz -18.0GHz



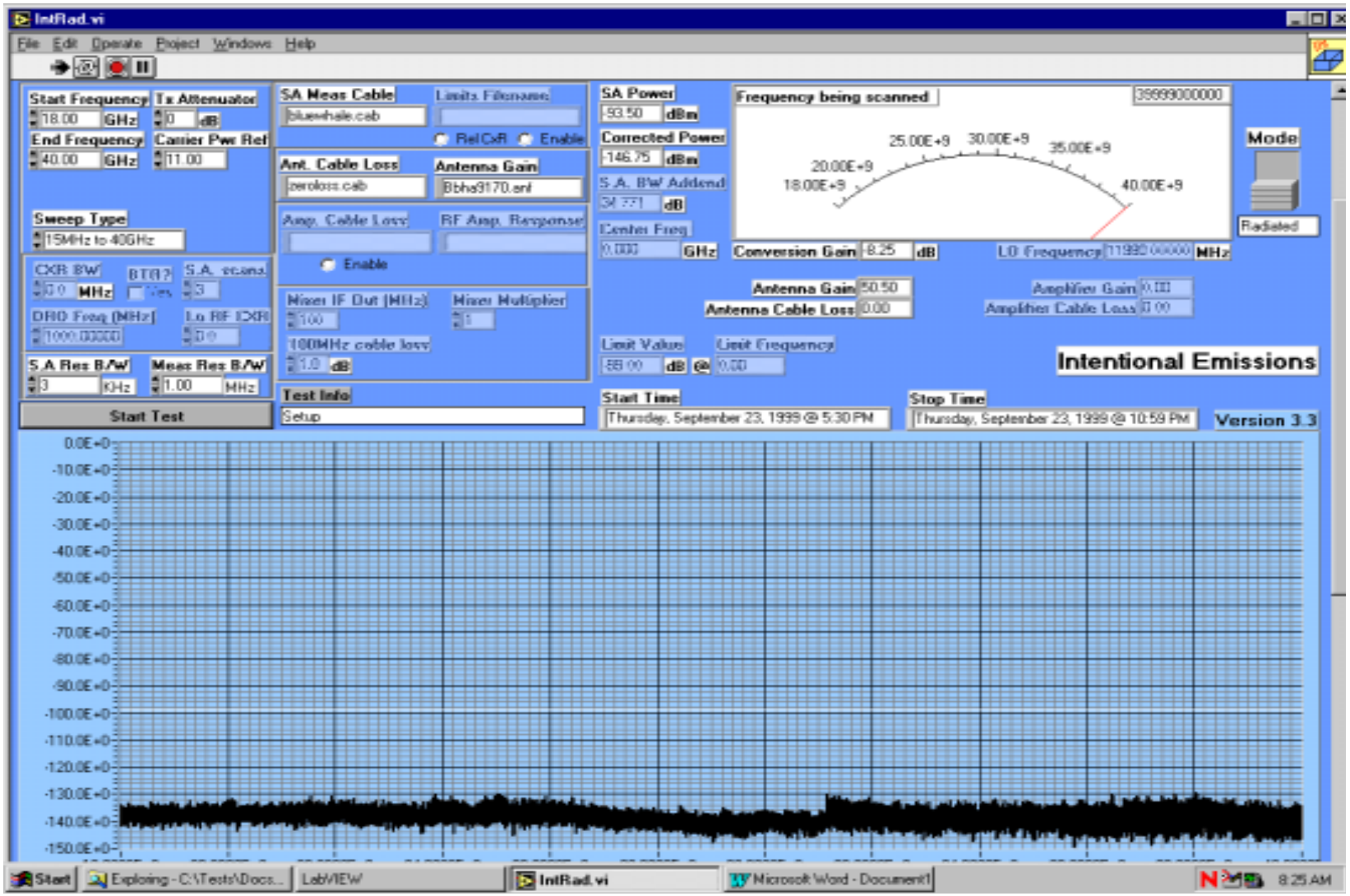
BTR 31-01P Horizontal Radiated Emission Test 2.0GHz -18.0GHz



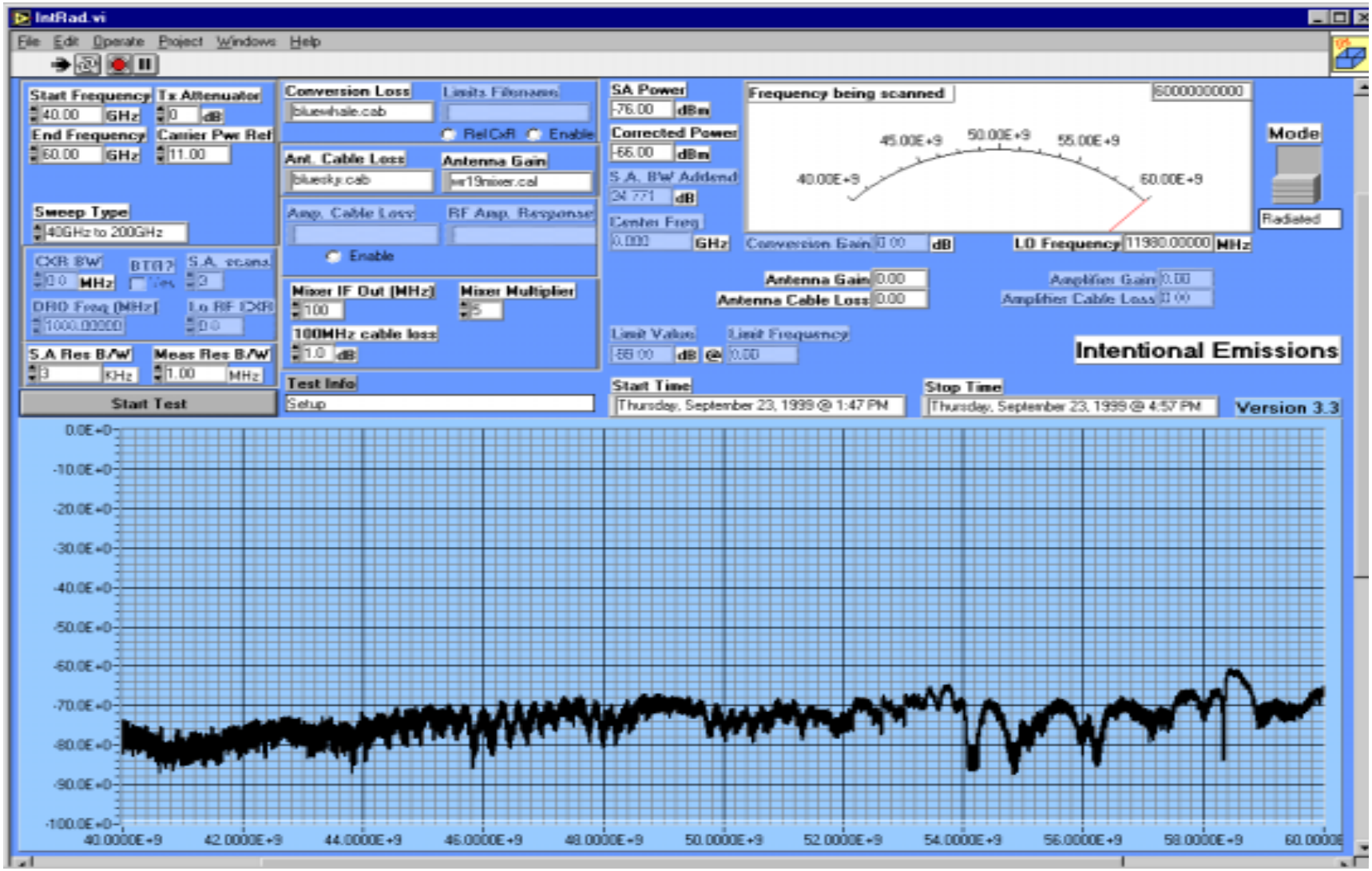
BTR 31-01P Horizontal Radiated Emission Test 18.0GHz-40.0GHz



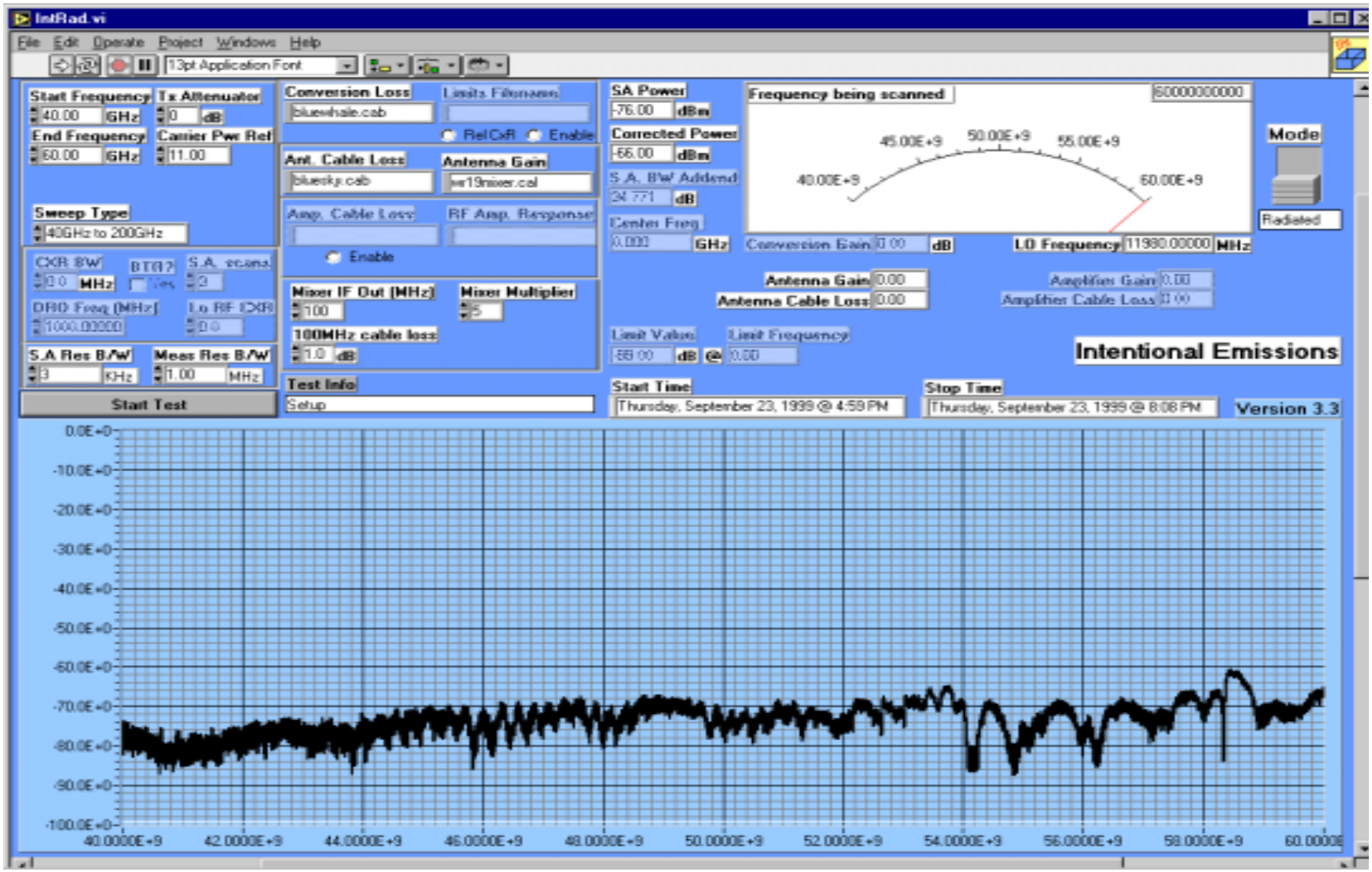
BTR 31-01P Vertical Radiated Emission Test 18.0GHz-40.0G



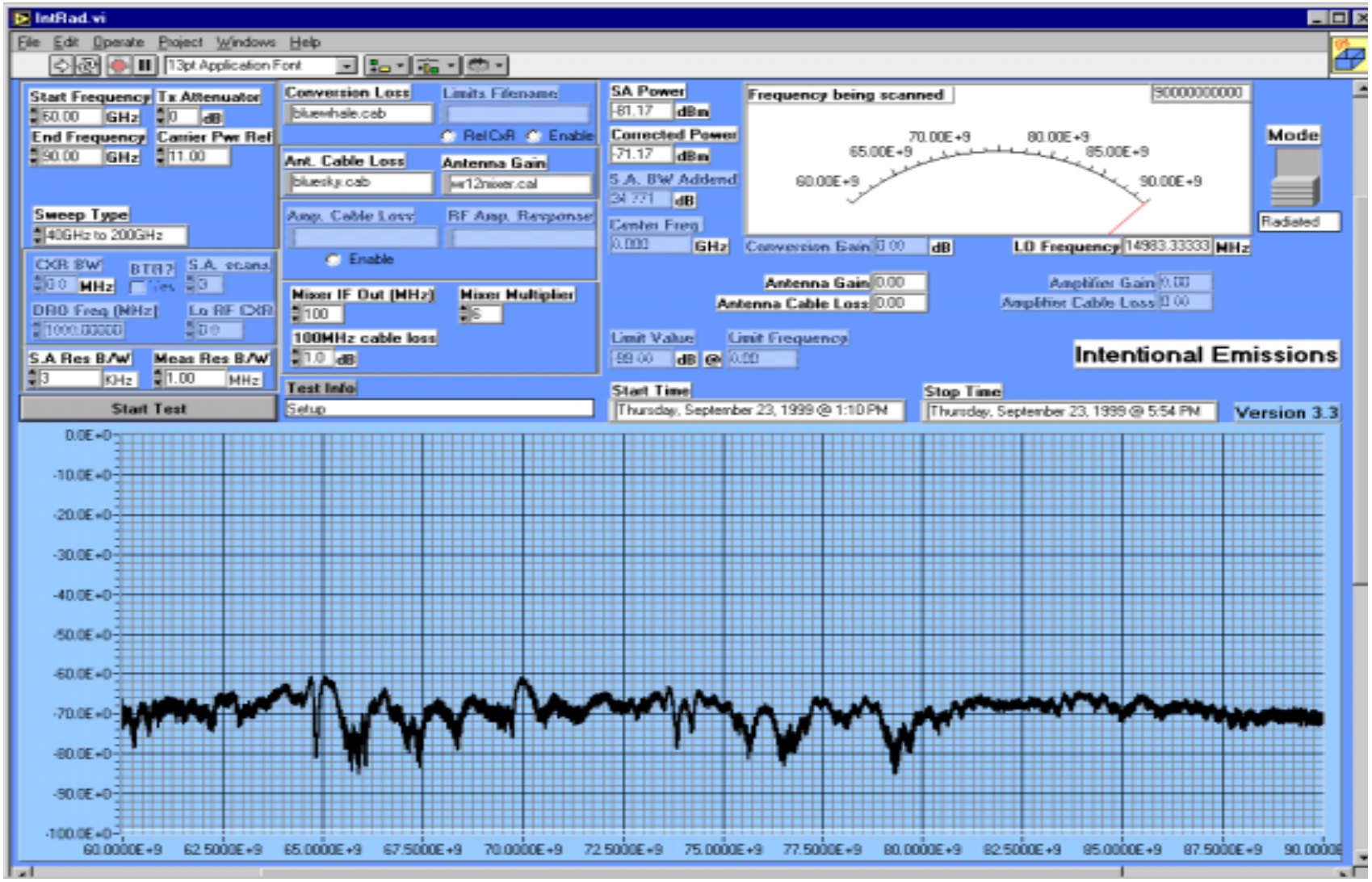
BTR 31-01P Vertical Radiated Emissions Test (40.0 GHz – 60.0 GHz)



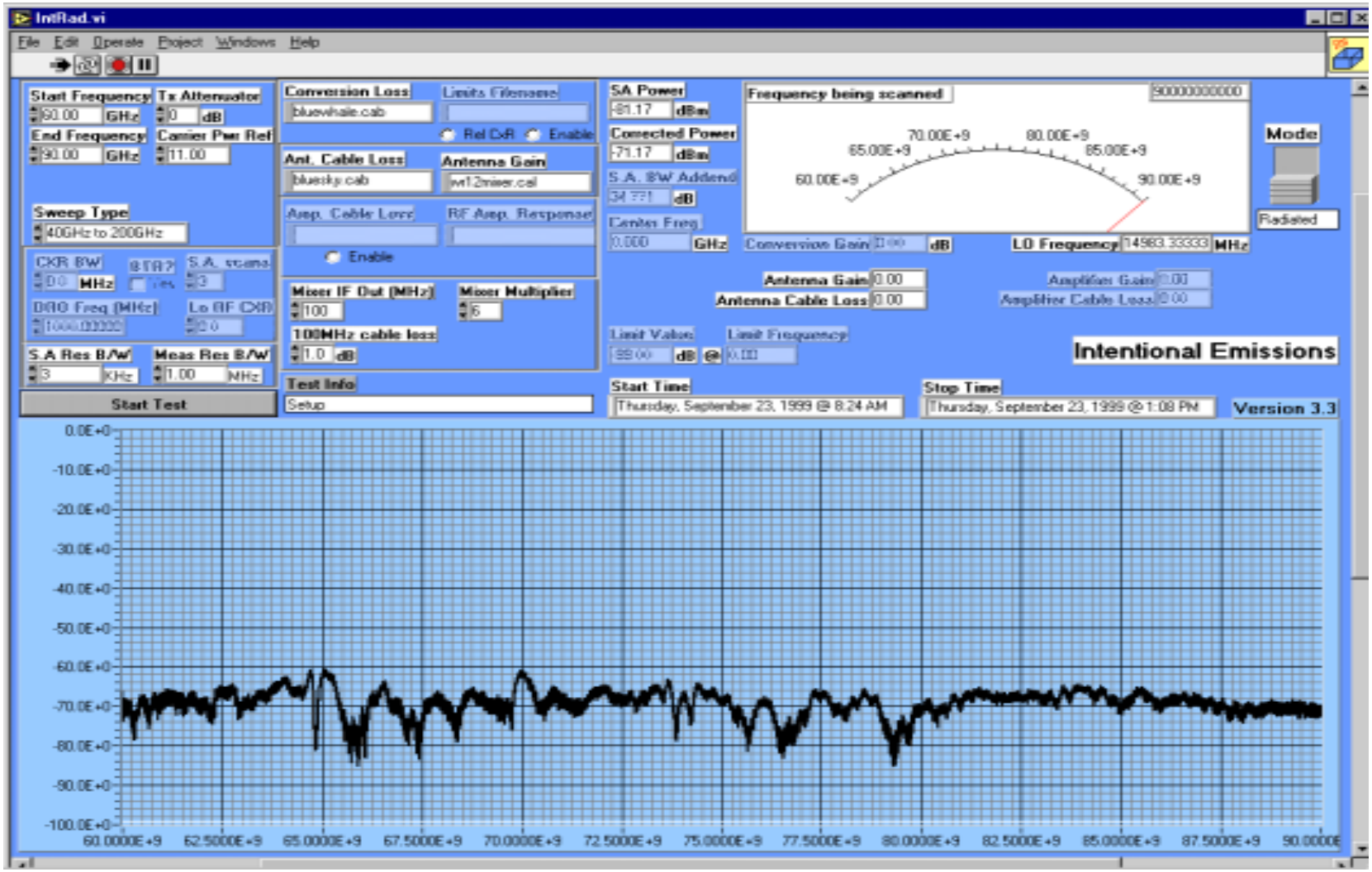
BTR 31-01P Horizontal Radiated Emissions Test (40.0 GHz – 60.0 GHz)



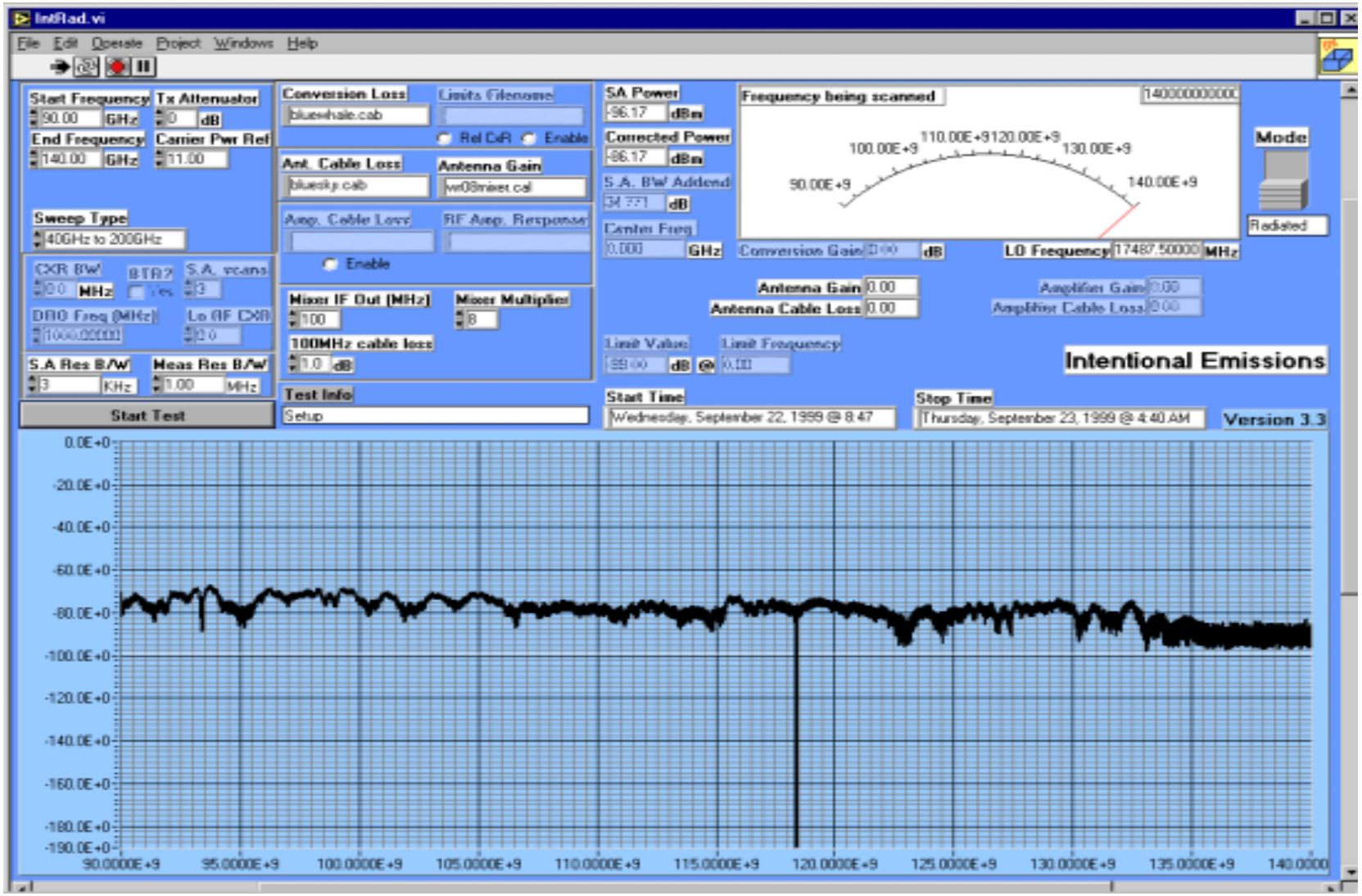
BTR 31-01P Vertical Radiated Emissions Test (60.0 GHz – 90.0 GHz)



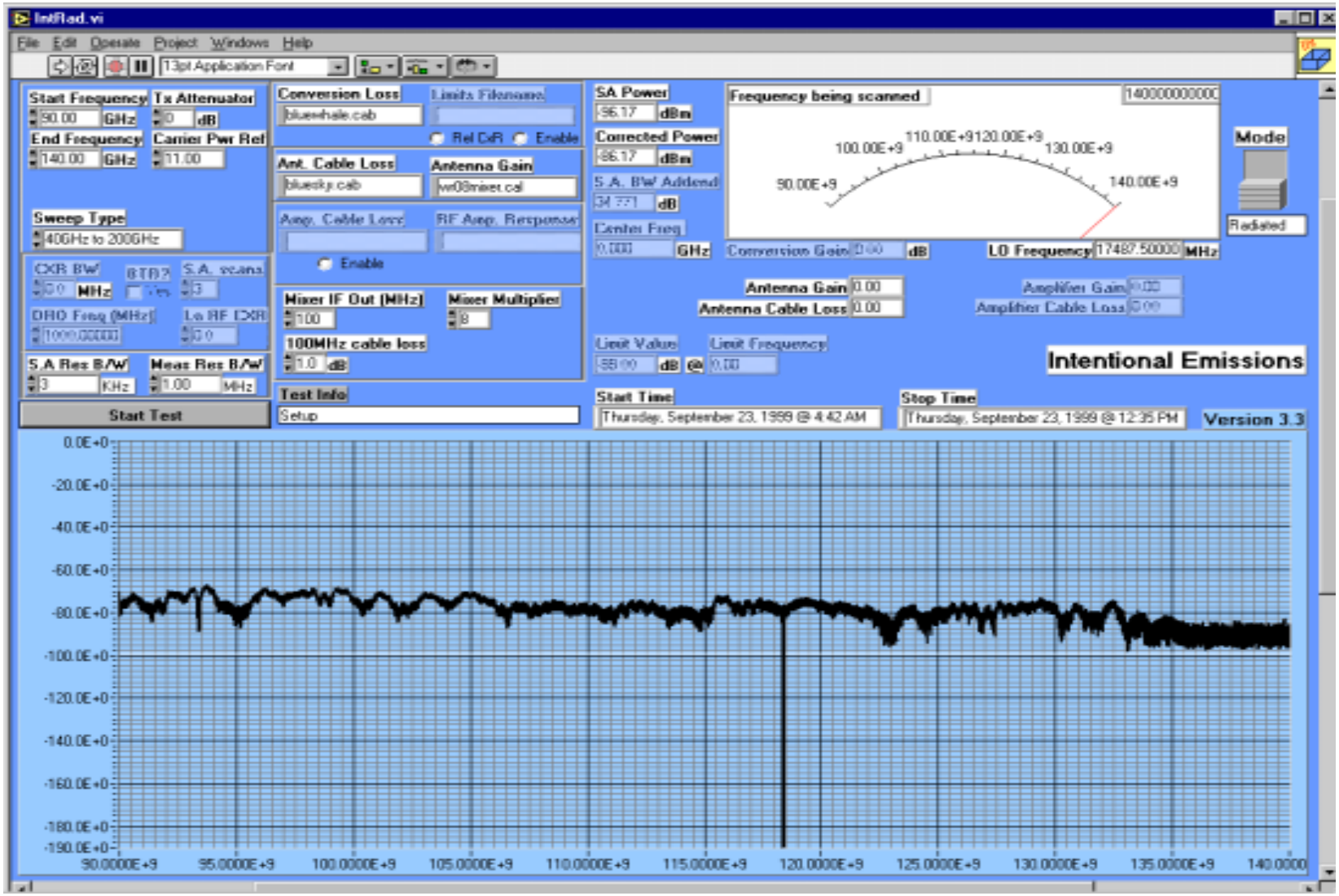
BTR 31-01P Horizontal Radiated Emissions Test (60.0 GHz – 90.0 GHz)



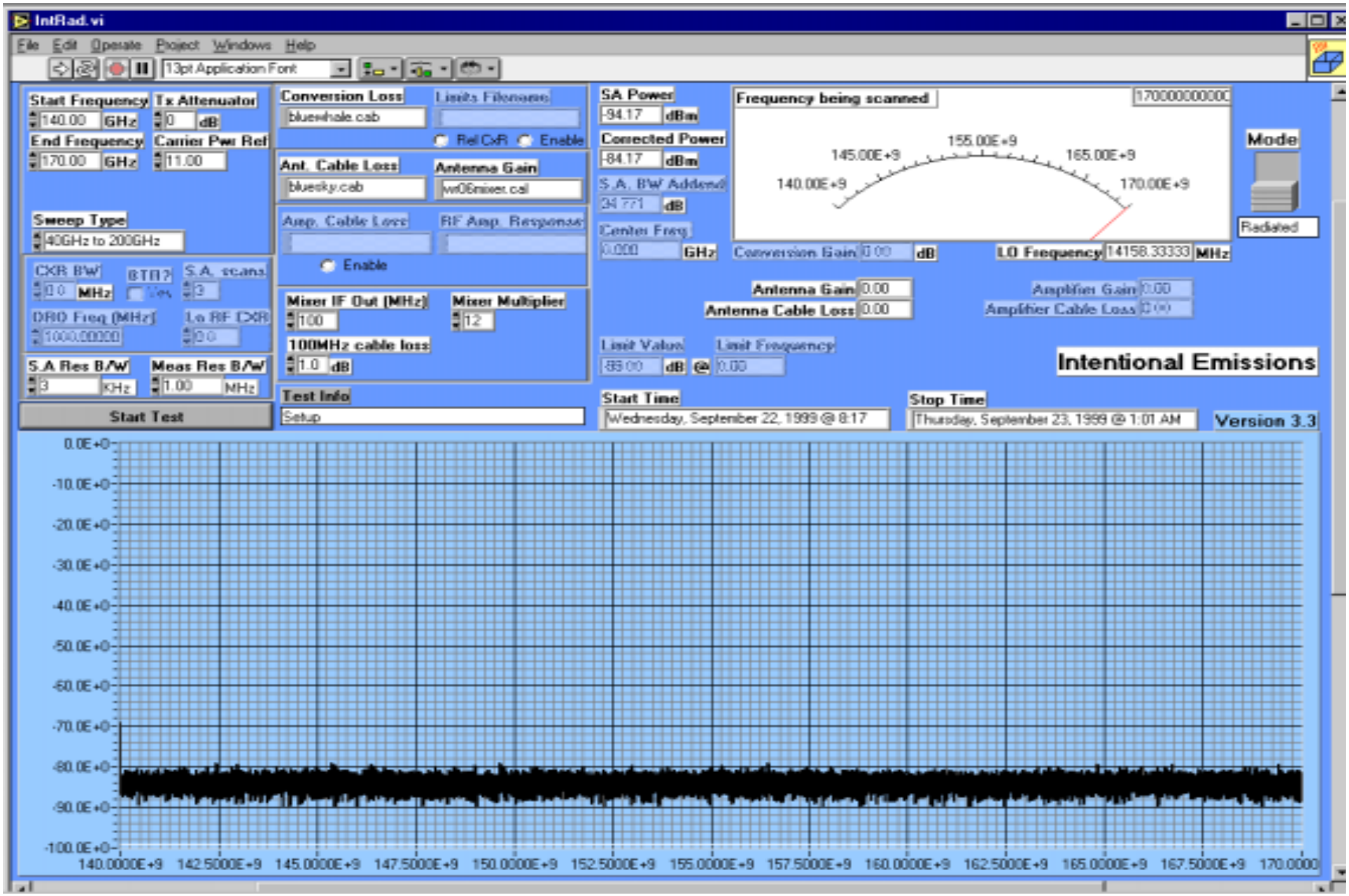
BTR 31-01P Vertical Radiated Emissions Test (90.0 GHz – 140.0 GHz)



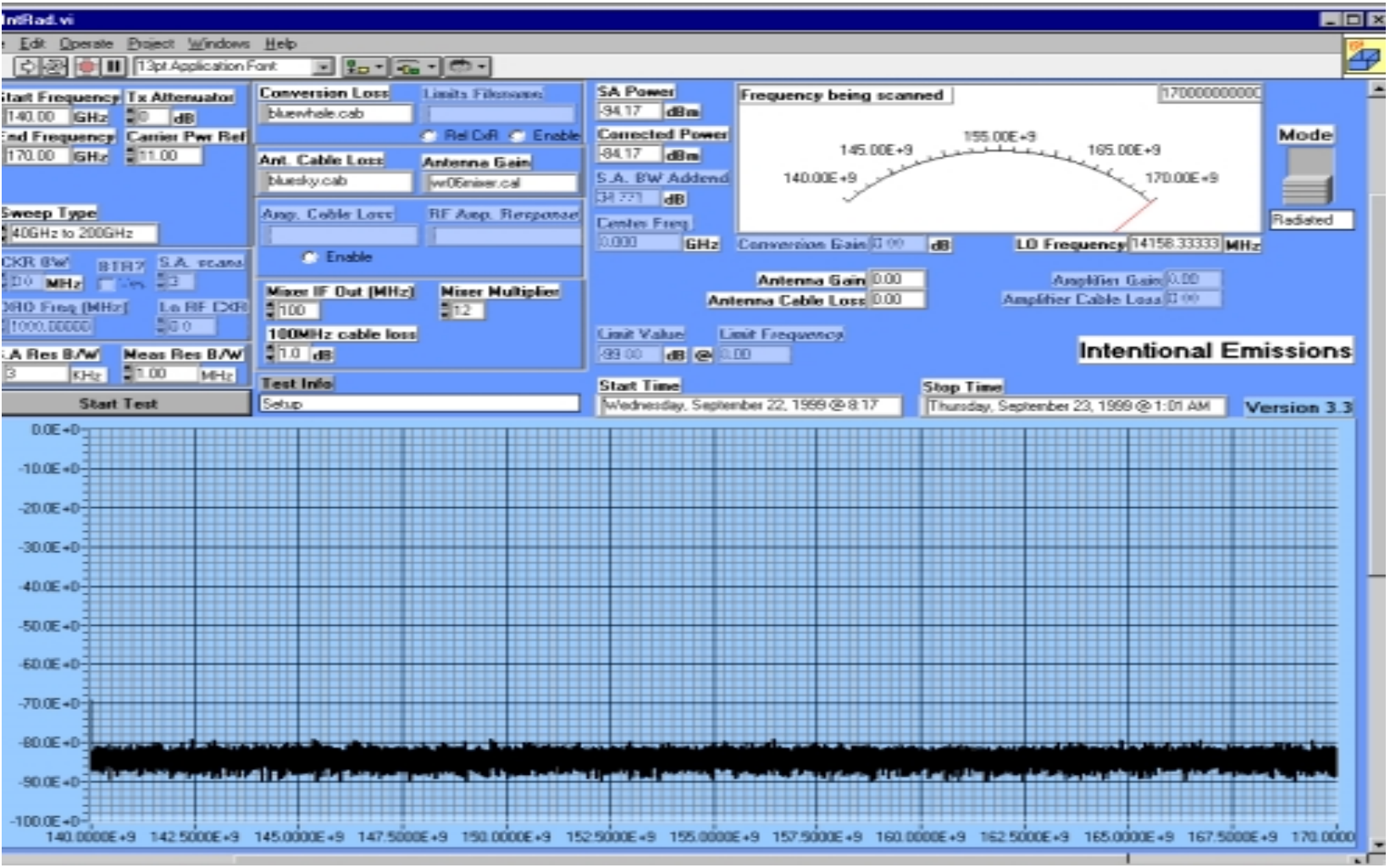
BTR 31-01P Horizontal Radiated Emissions Test (90.0 GHz – 140.0 GHz)



BTR 31-01P Horizontal Radiated Emissions Test (140.0 GHz – 170.0 GHz)



BTR 31-01P Vertical Radiated Emissions Test (140.0 GHz – 170.0 GHz)

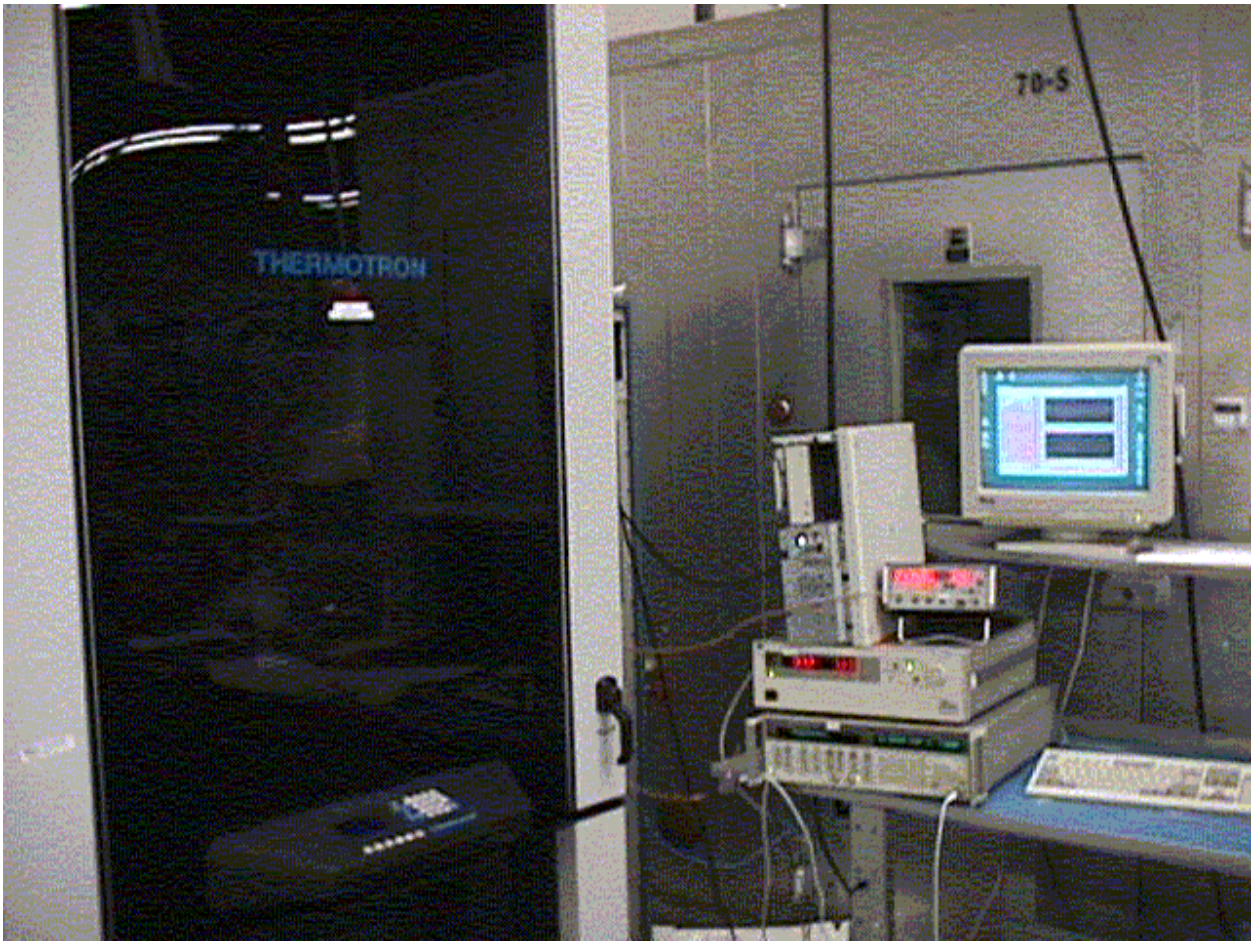


APPENDIX C

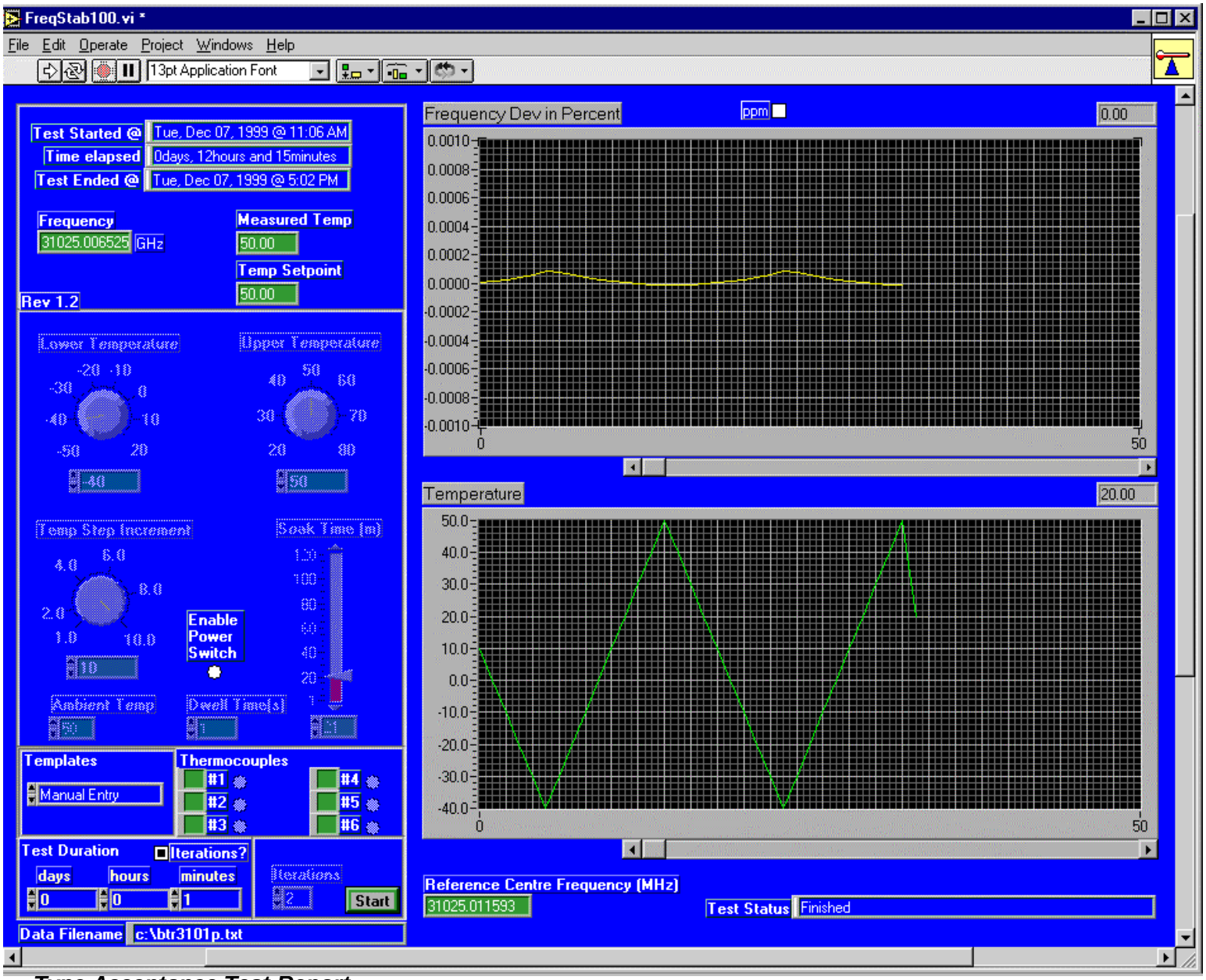
Temperature Stability Measurements Results

8. TEMPERATURE STABILITY MEASUREMENTS RESULTS

Frequency Stability Test Setup



BTR Frequency Stability



Test Date	Frequency (GHz)	Temp (C)	% Deviation
	31025.013151	20.0	--------
Tue Dec 07 1999 @ 11:26 AM	31025.013156	10.0	0.000005
Tue Dec 07 1999 @ 11:49 AM	31025.015955	0.0	0.000014
Tue Dec 07 1999 @ 12:11 PM	31025.019580	-10.0	0.000026
Tue Dec 07 1999 @ 12:33 PM	31025.024477	-20.0	0.000042
Tue Dec 07 1999 @ 12:55 PM	31025.030772	-30.0	0.000062
Tue Dec 07 1999 @ 1:18 PM	31025.037665	-40.0	0.000084
Tue Dec 07 1999 @ 1:40 PM	31025.035047	-30.0	0.000076
Tue Dec 07 1999 @ 2:02 PM	31025.029620	-20.0	0.000058
Tue Dec 07 1999 @ 2:25 PM	31025.023745	-10.0	0.000039
Tue Dec 07 1999 @ 2:47 PM	31025.018759	0.0	0.000023
Tue Dec 07 1999 @ 3:10 PM	31025.014900	10.0	0.000011
Tue Dec 07 1999 @ 3:32 PM	31025.012105	20.0	0.000002
Tue Dec 07 1999 @ 3:54 PM	31025.010142	30.0	-0.000005
Tue Dec 07 1999 @ 4:17 PM	31025.008478	40.0	-0.000010
Tue Dec 07 1999 @ 4:39 PM	31025.007296	50.0	-0.000014
Tue Dec 07 1999 @ 5:02 PM	31025.007434	40.0	-0.000013
Tue Dec 07 1999 @ 5:24 PM	31025.008253	30.0	-0.000011
Tue Dec 07 1999 @ 5:46 PM	31025.010270	20.0	-0.000004
Tue Dec 07 1999 @ 6:08 PM	31025.012481	10.0	0.000003
Tue Dec 07 1999 @ 6:30 PM	31025.015267	0.0	0.000012
Tue Dec 07 1999 @ 6:53 PM	31025.018912	-10.0	0.000024
Tue Dec 07 1999 @ 7:15 PM	31025.023410	-20.0	0.000038
Tue Dec 07 1999 @ 7:37 PM	31025.029649	-30.0	0.000058
Tue Dec 07 1999 @ 8:00 PM	31025.036454	-40.0	0.000080
Tue Dec 07 1999 @ 8:22 PM	31025.034017	-30.0	0.000072
Tue Dec 07 1999 @ 8:44 PM	31025.028457	-20.0	0.000054
Tue Dec 07 1999 @ 9:07 PM	31025.022750	-10.0	0.000036
Tue Dec 07 1999 @ 9:29 PM	31025.018087	0.0	0.000021
Tue Dec 07 1999 @ 9:52 PM	31025.014424	10.0	0.000009
Tue Dec 07 1999 @ 10:14 PM	31025.011713	20.0	0.000000
Tue Dec 07 1999 @ 10:36 PM	31025.009714	30.0	-0.000006
Tue Dec 07 1999 @ 10:59 PM	31025.007786	40.0	-0.000012
Tue Dec 07 1999 @ 11:21 PM	31025.006525	50.0	-0.000016

APPENDIX D

CHANNEL INTERFERENCE TESTS

9. CHANNEL INTERFERENCE TESTS

Adjacent Channel Test Results

4 QAM	Wanted	Hi-Side Interferor	Low-Side Interferor
	475MHz	485MHz	465MHz
Channel Power	-.41.3	-15	-18.4
Limit (0dB)	----	> -41.3	> -41.3
Pass Margin	----	26.3	22.9

16 QAM	Wanted	Hi-Side Interferor	Low-Side Interferor
	475 MHz	485MHz	465MHz
Channel Power	--34.5	-14.5	-17
Limit (0dB)	----	> -34.5	> -34.5
Pass Margin	----	20	17.5

64 QAM	Wanted	Hi-Side Interferor	Low-Side Interferor
	475 MHz	485MHz	465MHz
Channel Power	-28.9	-14.5	-17.4
Limit (0dB)	----	> -28.9	> -28.9
Pass Margin	----	14.4	11.5

Co-Channel Test Results

Frequency 475 MHz @ 4 QAM	Wanted	Interferor
Channel Power	-43.5	-54.5
Limit (19.5dB)	----	> -63
Pass Margin	----	8.5

Frequency 475 MHz @ 16 QAM	Wanted	Interferor
Channel Power	-45	-60.5
Limit (26.9dB)	----	> -71.9
Pass Margin	----	11.4

Frequency 475 MHz @ 64 QAM	Wanted	Interferor
Channel Power	-47.5	-65.5
Limit (33.1dB)	----	> -80.6
Pass Margin	----	15.1

APPENDIX E

SPECTRAL Mask Limit Calculations

10. SPECTRAL MASK LIMIT CALCULATIONS

BTR Mask

% Removed	FCC Spec	Delta BW, From pass band edge	Lower Band	Upper Band
0	0	0	31262.5	31262.5
50	0	37.5	31225	31300
50.5	-29.9506126	37.875	31224.625	31300.375
51	-30.1506126	38.25	31224.25	31300.75
55	-31.7506126	41.25	31221.25	31303.75
60	-33.7506126	45	31217.5	31307.5
75	-39.7506126	56.25	31206.25	31318.75
100	-49.7506126	75	31187.5	31337.5
101	-50.1506126	75.75	31186.75	31338.25
102	-50.5506126	76.5	31186	31339
105	-51.7506126	78.75	31183.75	31341.25
106	-52.1506126	79.5	31183	31342
107	-52.5506126	80.25	31182.25	31342.75
107.45	-52.7306126	80.5875	31181.913	31343.0875
115	-55.7506126	86.25	31176.25	31348.75
120	-57.7506126	90	31172.5	31352.5
125	-56	93.75	31168.75	31356.25
150	-56	112.5	31150	31375
175	-56	131.25	31131.25	31393.75
200	-56	150	31112.5	31412.5
250	-56	187.5	31075	31450
250.1	-43	187.575	31074.925	31450.075
300	-43	225	31037.5	31487.5
500	-43	375	30887.5	31637.5
1000	-43	750	30512.5	32012.5
1100	-43	440	30822.5	31702.5
1200	-43	937.5	30325	32200
1250	-43	937.5	30325	32200
1300	-43	975	30287.5	32237.5
1500	-43	1125	30137.5	32387.5